Growth of the Steel Industry.

There is probably no branch of the iron business that has not felt keenly competition from steel of late. The iron rail, as we all know, has been susperseded. The steel-nail production is rapidly increasing, and the output of iron nails is correspondingly decreasing. Structural shapes, bars, plates, sheets, bolts, rivets and many other miscellaneous manufactures were for many years only made of iron; now these articles may be purchased made of either iron or steel. Many establishments which produce miscellaneous articles of steel, and which purchased raw steel, have during late years constructed plants to produce their own steel.

The completed domestic Bessemer steel works number 28, containing 60 converters, while there are 6 works in course of construction, to contain 10 converters. Two years ago, as shown by the directory of the American Iron and Steel Association, there were but 20 Bessemer works, containing 45 converters. Seven of these new Bessemer steel works have made their first blow since the first of February. When the unfinished works are completed the annual capacity of the combined works will be 4,000,000 net tons, as compared with a capacity two years ago of nearly 2,500,000 tons.

There are 6 completed works using the Clapp-Griffiths' process, with 10 converters, besides 2 building, to contain 3 converters. On the 1st of January last there was but one of these plants completed and in operation.

During the present year, therefore, twelve new steel works have gone into operation. This great increase in the number and capacity of the works using the Bessemer and Clapp-Griffiths' processes has been in the erection of plants for the production of steel for purposes other than for rails. The surplus blooms and billets that come on the market from establishments founded to supply steel for nail, plate and other miscellaneous finished steel comes in direct competition with blooms and billets from open-hearth steel works. The Bessemer steel-rail mills would also compete for some of this business in dull seasons.

Open-hearth steel plants have been erected during the past two years as well. While there were 35 completed open-hearth steel works, containing 63 furnaces, two years ago, there are now 42 completed works, embracing 91 furnaces. Seven new works are in course of construction. The Carnegie, Phipps & Co. open-hearth steel plant at Pittsburgh, when completed, will contain four 35-ton furnaces. The capacity of the works in 1884 was 550,000 net tons; it is now estimated at 660,000 tons. But these figures, while exhibiting the progress that has been made in this industry, are otherwise without significance, as the works have not in the past been run at their full capacity.

It is the manufacturers of the higher grades of rolled iron that are now feeling the competition from these open-hearth steel works. In the competition between the various steel processes for the finished iron business the crucible steel process has taken no part.—*Bradstreets.*

Electric Motors.

At the Electrical Convention held in Detroit, Mich. on the 3rd, a paper on "The Operation of Motors from Electric Light and Power Stations," by T. C. Martin of New York was read. It discussed the economy of their operation, and said that where an electric light could exist electric motors could be installed on a renumerative basis.

"Their success," said the writer, "though tardy in coming, depends upon improvements in primary batteries, in secondary batteries, in dynamos, steam engines, boilers and furnaces burning cheap fuel, upon improvements in wires and in line construction, upon the development of modern ideas of urban convenience.

Over 1,000,000 passengers, he said, had already been carried by the electric railways of the United States and in Europe that number has been exceeded. The cost of electrical power thus applied is $12 per day as against $18 for horses, and the cost per passenger in 1885 was eighty-three cents as compared with $1.55 in 1884.

The systems in use throughout the country are the Daft, used at Revere Beach, Mass., Los Angeles, Cal., and elsewhere; the Vandepoele at Minneapolis, Minn., Montgomery, Ala., Windsor, Ont., Detroit, Scranton, Pa., and Appleton, Wis; the Schlesinger, at Philadelphia; the Bentley-Knight, at Providence, R.I., and the Sprague, which has been employed with success on the New York Elevated road.

The number of electric motors in use in this country for business purposes is about 3,000. There are about 250 operated in Philadelphia by the Brush Company; at Chicago, where motors are manufactured, one is employed to run the press of a newspaper, another a gunsmith's lathe and two others to cut up sausage.

Engineer's Surveying Instruments,—Their Construction and Use.

III

Written for ENGINEERING NEWS.

BY I. O. BAKER, C. E. PROFESSOR OF CIVIL ENGINEERING UNIVERSITY OF ILLINOIS.

VERNIERS.

1. PRINCIPLES. A vernier is a short scale movable by the side of a longer scale, by which subdivisions of the longer scale may be measured. The scale to be subdivided is called a limb. A division of the vernier is a a little shorter or longer than a division of the main scale or limb. The small difference is the space which is measured by the vernier.

A vernier may be constructed by taking a length equal to any number of parts of the limb, and dividing it into a number of equal parts, one more or one less than the number into which the same length on the limb is divided.

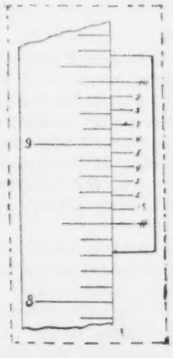

FIG. 5

For example, the limb shown in Fig. 5, is a scale of inches divided into tenths, the vernier beside it is capable of measuring to hundredths. Notice that the ten spaces of the vernier are equal to nine of the limb. Therefore each space of the vernier is equal to 0.1 of 0.9 = 0.09 of an inch; it is 0.01 of an inch shorter than a space of the main scale.

The first mark of the vernier falls short of a mark on the limb by 0.01 of an inch; the second falls short by 0.02 of an inch, and so on. Therefore if the vernier be moved slowly forward the successive coincidences of a line on the vernier with one on the limb will indicate successive advances of the vernier, each equal to 0.01 of an inch. If the lines of the vernier are numbered as in Fig. 5, the number on the vernier of the line which coincides will indicate the amount that the zero of the vernier has passed a division of the limb.

2. DIRECT AND RETROGRADE VERNIERS.—In the above illustration the spaces on the vernier are shorter than those on the limb; the supposed motion was in the direction of the graduation of the limb, and the successive lines of the vernier came into coincidence also in the direction of the graduation; the numbering on the limb and also on the vernier increase in the same direction. Therefore Fig. 5, is a *direct* vernier.

If the spaces on the vernier are larger than those of the limb and the vernier is moved in the direction of the graduation of the limb, the successive coincidences will occur in the direction opposite to the motion and also opposite to the direction of the graduation on the limb; therefore, the lines on the vernier should be numbered in an opposite direction to those on the limb. Such an arrangement is a *retrograde* vernier; see Fig. 7.

The direct vernier is much more common; it is shorter and more convenient to read. A retrograde vernier is used when the lines of a direct vernier would be inconveniently close together.

3. LEAST COUNT.—The least count of a vernier is the difference in length between a space on the limb and one on the vernier. To find the least count of a vernier, *i e*, to determine how small a distance it can measure, let l = the length of a division on the limb; v = a division on the vernier; and n = the total number of spaces on the vernier; then by the principle of the vernier, $nl = nv \pm l$, solving which gives, $l - v = \frac{l}{n}$, the least count.

For example in Fig. 5, $l = 0.1$, and $n = 10$; hence the least count equals $\frac{l}{n} = \frac{0.1}{10} = 0.01$

The above formula expresses a very important relation; it is the key to reading all verniers. Notice that the least count of the vernier is equal to the smallest division on the limb divided by the number of spaces on the vernier. In practice, it is not necessary to count n; it is indicated by the numbering on the vernier itself. For example, if the limb is divided to half degrees and there are thirty, spaces on the vernier, which would be indicated by the end line being numbered thirty the vernier reads to one-thirtieth of a half degree or to minutes.

Notice that the above relation is true for both direct and retrograde verniers.

4. TO READ A VERNIER.—Look at the zero line of the vernier; if it coincides with a division of the limb, the number of that line on the limb is the correct reading, the vernier divisions not being required, But if, as usually happens, the zero of the vernier comes between two divisions of the scale, note the nearest division on the limb next less, and then look along the vernier till a line is found which exactly coincides or forms a straight line with some line on the limb. The number of this line on the vernier is the distance between the zero of the vernier and the next lower division of the limb, and must be added to the reading taken from the limb.

A number of examples will now be given to further illustrate these general principles. The student should draw the limb and scale on separate slips of paper or card board, and move one beside the other until he can read them in any position.

5.—The vernier shown in Fig. 6, is the one used on the New York leveling rod,

FIG. 6.

The main scale is divided to feet, tenths and one hundredths; ten divisions of the vernier are equal to nine of the limb; therefore, the vernier reads to tenths of one-hundreths, or to one-thousandths. The vernier as drawn reads 3 feet, 0 tenths, three hundreths, and seven thousands, or 3.037 feet.

6. Fig. 7, shows part of a circle graduated to degrees and half degrees; the vernier has thirty parts, therefore it reads to single minutes. The reading is $210° 30' + 8' = 210° 38'$. This is a very common vernier for engineering instruments.

7. The graduation of transits usually has two rows of numbers, one increasing to the right and the other to the left; in this case there are two verniers, one for each series of numbers. Such an arrangement is shown in Figure. 8. Each vernier is like the one described in the preceding paragraph, and is read in the same way. The reading of the left hand vernier is 181° 30′ + 12′ = 181° 42′ with the outer numbers, and 1° 42′ with the inner. The right hand vernier reads 167° 12′.

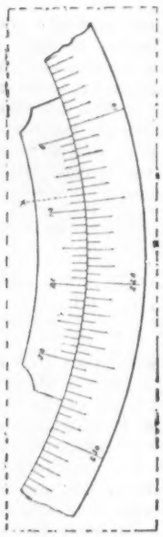

FIG. 7.

There is sometimes a doubt as to which vernier should be read. First notice whether the vernier divisions are larger or smaller than those on the limb. If the spaces on the vernier are the smaller, it is a *direct* vernier, and that vernier should be read the numbers of which increase in the *same* direction as those on the limb. If the spaces on the vernier are the larger, it is a *retrograde* vernier, and that vernier should be read the number of which increase in the *opposite* direction to those on the limb.

Or the vernier to be read can always be determined as follows; move the vernier, until say, the ten mark of one vernier and the twenty of the other coincides each with a line on the limb; look at the zero, estimate the reading, and then read the vernier that agrees most nearly with the estimated reading.

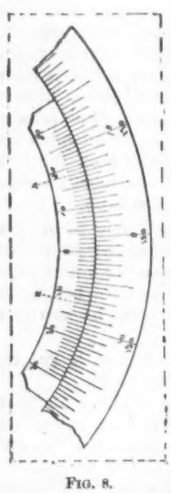

FIG. 8.

In Fig. 8, the numbers on the vernier are inclined in the same direction as the numbers on the limb to which the vernier belongs. Instruments are not made in this way, but such an innovation would be a great improvement.

8. Fig. 9, is another form of double vernier; it is often applied to the compass, to be used in setting of the declination. Notice that this form is only half as long as the double vernier of Fig. 8.

It is used where there is not space for the longer one is called a double folded vernier.

The lower numbers on one side of the zero and the upper ones on the other side constitute a vernier. The proper vernier to be read, in any given case, can be determined by either of the rules of the preceding article. The vernier as drawn, reads 2° 30′ + 12 = 2° 42′ to the right. Notice that the reading of the vernier is 12′ not 17′.

9. PRACTICAL HINTS. To determine exactly which lines coincides best, notice the next line on either side and see whether they fall short equal amounts. When several lines on the vernier appear to coincide equally with several lines of the limb, take the middle line. When no line coincides, but one line on the vernier is on one side of a line on the limb, and the next line on the vernier is as far on the other side of it, the true reading is midway between the readings indicated by these two lines. If the graduation is very accurate and the lines fine, it is possible, by this method, to estimate the reading to half, or even to thirds, of the least count.

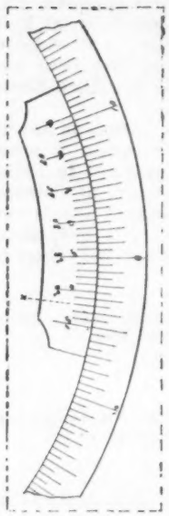

FIG. 9.

It frequently happens that the instrument is to be used to lay off a number of equal angles, as for example, 1°; the vernier is then to be set each time at some particular mark. If it is a double vernier, set the zero line to coincide each time, and notice whether the lines next on either side fall short an equal amount; if it is a single vernier, set, say, the fifteen line to coincide, and note the agreement on both sides. This process is considerably more accurate than setting the end line of the vernier to coincide each time.

The most frequent error in reading a vernier is to omit part of the reading of the limb; for example, in Fig. 7, forgetting to record the half degree from the limb.

Municipal Engineering; Paper No. 3.*

WASHINGTON, D. C.

(*Continued from Page* 148.

Footways.

The footways on the north side of Pennsylvania avenue between First street and Fifteenth street are mostly of artificial stone (granolithic) and are laid to a slope of half an inch to a foot. There is none of this pavement being laid by the city at the present time on account of the cost, but property owners are allowed to put it down at their own expense.

There is a small amount of asphalt sidewalk in the city, but it is no longer being laid.

Brick pavement laid with a slope of a quarter of an inch to a foot is the only sidewalk now put down at the expense of the city. Around all trees there are openings left, about 3 feet by 8 feet.

Specifications for Laying Asphaltum Pavements on Sidewalks.

1. Asphaltum pavements for sidewalks will be one and one-half (1½) inches in thickness when compressed, with a base of hydraulic cement-concrete 4 inches in depth.

2. The present brick pavement will be taken up and the bricks may be broken and used by the contractor as material for concrete. The sand beneath the present brick pavement, and all other material necessary to be removed, will be taken out to a depth of 5¼ inches below the surface of the new pavement when completed, and will be removed from the street; soft or spongy places, not affording a firm foundation, will be dug out and refilled with good earth, well rammed, and the entire road-bed will be thoroughly rolled with a stone or iron roller weighing not less than 150 pounds to the inch run. The slope of the pavement will be a rise of one-half (½) inch to the foot from the curb, unless otherwise specially ordered.

Upon the foundation as above will be laid a bed of hydraulic cement-concrete 4 inches in thickness, to be made as follows: One measure of cement equal to the best quality of freshly-burned Rosendale cement and two of clean sharp washed sand, free from clay, will be thoroughly mixed, dry, and then made into a mortar with the least possible amount of water; broken stone or brick, thoroughly cleaned from dust and dirt, drenched with water, but containing no loose water in the heap, will then be incorporated immediately with the mortar in such quantities as will give a surplus of mortar when rammed. This proportion, when ascertained, will be regulated by measure. Each batch of concrete will be thoroughly mixed, the mixing being continued on the board until each piece of stone or brick is completely coated with mortar; it will then be spread and at once thoroughly compacted by ramming until free mortar appears upon the surface. The whole operation of mixing and laying each batch will be performed as expeditiously as possible, with the use of a sufficient number of skilled men. No gravel will be used in the concrete, but only angular fragments of stone or brick, having rough faces obtained by fracture, and measuring not more than one and a half inches in their largest dimensions. The upper surface will be made exactly parallel with the surface of the pavement to be laid, and will be protected from the action of the sun and wind until set. Upon this base will be laid the wearing surface or pavement proper, the basis of which, or paving cement, will be pure asphaltum, unmixed with any of the products of coal-tar.

3. Openings will be left around the trees of such dimensions as may be ordered by the Engineer Commissioner, and these openings will be protected by 2 inch curb, against which the pavement will be laid. This curb will be furnished by the District at the G-street property yard, it will be hauled, cut if necessary, and set by the contractor without extra charge.

4. The following specifications for wearing surface will be adhered to, unless a more satisfactory pavement should be presented:

The wearing surface will be composed of—

1st. Refined Trinidad or Cuban asphaltum.

2d. Heavy petroleum oil.

3d. Fine sand, containing not more than five per centum of hydrosilicate of alumina.

4th. Fine powder of carbonate of lime.

The Trinidad asphaltum, (so-called,) whether crude or refined, as found in this market, contains from twenty to thirty-five per centum of impurities, and must be refined and brought to an uniform standard of purity and gravity.

The Cuban asphalt contains a greater percentage of asphaltine and less of petrolene than the Trinidad asphalt, and therefore requires a larger percentage of heavy petroleum oil to make an asphaltic cement of a similar quality as to its malleability.

The heavy petroleum oil, which may be the residuum by distillation of the petroleum oils, as found in the market, generally contains water, light oils, coke, and a gummy substance soluble in water. This petroleum oil must be freed from all impurities and brought to a specific gravity of from 18° to 22° Beaumé, and a fire test of 250 Fahrenheit.

By melting and mixing these two hydro-carbons, petroleum oil and asphaltum, the matrix of the pavement called asphaltic cement is manufactured, which cement shall have a fire test of 250° Fahrenheit, and be of a gravity of one hundred and nineteen degrees at 60° Fahrenheit.

They will be mixed in the following proportions by weight:

With Trinidad Asphalt.

Pure asphalt	100 parts.
Heavy petroleum oil	20 parts

With Cuban Asphalt.

Pure asphalt	100 parts.
Heavy petroleum oil	30 parts.

The purity of the asphalt shall be ascertained and the quantity of heavy petroleum oil to be added to it shall be in accordance with the percentage of pure asphalt which it contains when crude, whether Cuban or Trinidad asphalt.

The asphaltic cement being made in the manner above described, the pavement mixture will be formed of the following materials and in the proportions stated:

Asphaltic cement	from 18 to 20	
Sand	" 66 "	64
Pulverized carbonate of lime	" 16 "	16
	100	100

The sand and asphaltic cement are heated separately to about three hundred degrees Fahrenheit. The pulverized carbonate of lime, while cold, is mixed with the hot sand in the required proportions, and is then mixed with the asphaltic cement at the required temperature, and in the proper proportion, in a suitable apparatus, which will effect a perfect mixture.

The asphalt having been prepared in the manner thus indicated, will be laid on the foundation in two coats. The first-coat of one-half inch thickness, called cushion coat, will be laid with at least twenty-two per centum of asphaltic cement. This first coat will be well consolidated by rolling or otherwise. On this first coat will then be spread with iron rakes the final finishing coat, prepared as above indicated. It will be brought to the ground in carts at a temperature of about two hundred and fifty degrees Fahrenheit, and spread to a depth such that when compressed two-fifths the thickness shall be one inch. It will then be compressed by rollers weighing not less than 150 pounds to the inch run, until the required degree of compression is obtained.

All materials used will be subject to inspection, and

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will be of the quality and kind now on file in the office of the Engineer Commissioner.

The powdered carbonate of lime will be of such degree of fineness that 16 per centum by weight of the entire mixture for the pavement shall be an impalpable powder of limestone. The amount of fine sand will be proportioned so as to include as sand the coarser particles of pulverized carbonate of lime. The degree of fineness, both of sand and powdered limestone, will be determined by testing with the screens now on file in the Engineer Department.

Those portions of the pavement next to the curb, and next to the park wall, for a width of three inches in each case will be coated with hot pure asphalt, which will also be poured into the joint, and smoothed with hot smoothing-irons in order to make the joint impervious to water.

Specifications for Laying Brick Sidewalks.

1. Brick pavements will be laid on a foundation of gravel and sand.

2. The bricks will be furnished by the District delivered on the line of the work.

3. The space over which the pavement is to be laid will be excavated to the depth of ten (10) inches below the top surface of the proposed new pavement, when fully rammed. Should there be any spongy material or vegetable matter in the bed thus prepared, all such material shall be removed and the space filled with clean gravel or sand. Care must be taken in excavating to preserve the proper slope, which will be a rise of one-fourth (¼) of an inch to the foot, unless otherwise ordered. All holes and inequalities will be filled to a proper level with sand or gravel only, such filling to be well and faithfully compacted by rolling or ramming.

4. Upon the foundation as above is to be laid a bed of fine bank gravel, to be approved by the Engineer Commissioner, four inches in depth when compressed, to be screened from all pebbles measuring more than one and one-half (1½) inches in their largest dimensions, and to be thoroughly rolled and rammed. Upon this will be laid a bed of fine, sharp, washed sand, thoroughly dry, four (4) inches in thickness, to serve as a bed for the bricks, which will be laid directly upon and embedded in it with close joints. Special care will be observed to make the surface of this bed of sand exactly parallel to the surface of the pavement when complete; this will be accomplished by dragging a straight-edge over it, or otherwise. The bricks must be laid by the pavers standing or kneeling upon the bricks already laid, and not upon the bed of sand.

The bricks are to be laid at right angles with the line of the street and even with the top of the curb when rammed; each course to be of bricks of an uniform width and depth, and so laid that all longitudinal joints shall be broken by a lap of at least two (2) inches. Each course of bricks will be driven against the course preceding it by a maul, in order to make the joints as tight as possible. When thus laid the bricks will be immediately covered with clean, fine sand, entirely free from any loam or earthly matter, perfectly dry, and screened through a sieve or screen having not less than twenty meshes to the inch. The bricks will then be carefully rammed by placing a plank over several courses and ramming the plank with a heavy rammer. The ramming will be continued until the bricks reach a firm, unyielding bed and present a uniform surface, with proper grade and slope. Any lack of uniformity in the surface must be corrected by taking up and relaying the bricks. When the ramming is complete a sufficient amount of fine, dry sand, as above described, will be spread over the surface and swept or raked into the joints.

Street Lamps.

Some attempts at lighting the streets with electricity have been made, but at present they are lit entirely by gas. The usual style of lamp is shown in Plate 2. The aggregate number of lamps is 4,416. These are each lighted 2,600 hours during the year, and are lit and extinguished according to a schedule prepared by the District Commissioners. Lamps are usually placed on diagonally opposite corners of street intersections, about one foot from the curb line (in the sidewalk), of one street and near the parking line of the other street, or about 12 feet from the other curb. Between street corners they are placed about 150 feet apart, and about one foot from the curb, in the sidewalk. The lamps are lighted and extinguished by the gas company. The force employed consists of two inspectors and forty-three lighters, one man lights from 80 to 110 lamps. Each lighter is furnished with a light ladder, a pair of pliers, and a small lamp for lighting; but most of the men do not carry either the ladder or the lamp, claiming they can light a lamp quicker by stepping upon the base of the post, and using a match.

Inspector of Cements and Asphalts.

It is the duty of the Inspector of Cements and Asphalts to inspect and test samples of all cements or limes used in the public works of the District, of all asphalt used in the pavement of streets, to make analyses of water, food, or other substances for the health department, to make analyses for the coroner and police in cases of suspected poisoning, etc. For this purpose he has a laboratory fitted up with all necessary apparatus for making both chemical and physical tests. Much available information in regard to the composition and behavior of cements can be obtained from his reports, which are to be found in the Annual Reports of the Commissioners of the District of Columbia.

Property Clerk.

All supplies of whatever kind for the use of the District are purchased by, and kept in charge of the Property Clerk, and are issued by him on requisitions required by the proper officers.

All granite paving blocks, curb stones, gutter flag, sewer pipe, junction blocks, etc., for contract work, as well as for permit work, are kept in store by the Property Clerk.

(TO BE CONTINUED).

The Trigonometrical Survey of India.*

(*Concluded from page 151.*)

Many regions, as the basin of the Mahanaddi, the valley of Assam, the hill ranges of Tipperah, Chittagong, Arracan, and Burma, and those to the east of Moulmein and Tennasserim, which form the boundary between the British and the Siamese territories, are covered with dense forests, up to the summits of the peaks which had to be adopted as the sites of the survey stations. As a rule the peaks were far from the nearest habitation, and they could not be reached until pathways to them had been cut through forests tangled with a dense undergrowth of tropical jungle; not unfrequently large areas had to be cleared on the summits to open out the view of the surrounding country. Here the physical difficulties to be overcome were very considerable, and they were increased by the necessity that arose, in almost every instance, of importing laborers from a great distance to perform the necessary clearances. But the broad belt of forest tract known as the Terai, which is situated in the plains at the feet of the Nepalese Himalayas, was the most formidable region of all, because the climate was very deadly for a great portion of the year, and more particularly during the season when the atmosphere was most favorable for the observations, though the physical difficulties were not so great as in the hill tracts just mentioned, and labor was more easily procurable.

Lying on the British frontier, at the northern extremities of no less than ten of the meridional chains of triangles, it had necessarily to be operated in to some extent, and Everest wished to carry the several chains across it, on to the outer Himalayan range, and then to connect them together by a longitudinal chain running along the range from east to west, completing the gridiron in this quarter.

But the range was a portion of the Nepalese territories, and all Europeans—excepting those attached to the British embassy at Khatmandu—were debarred from entering any part of Nepal, by treaty with the British Government.

Everest hoped that the rulers of Nepal might make an exception in his favor for the prosecution of a scientific survey; and when he found they would not, he urged the Government to compel them to give his surveyors access, at least, to their outlying hills; but he urged in vain, for the Government would not run the risk of embarking in a war with Nepal for purely scientific purposes. Thus the connecting chain of triangles—now known as the N. E. Longitudinal Series—had to be carried through the whole length of the Terai, a distance of about 500 miles, which involved the construction of over 100 towers—raised to a height of about 30 feet to overlook the earth's curvature—and the clearance of about 2,000 miles of line through forest and jungle to render the towers mutually visible.

It required no small courage on Everest's part to plunge his surveyors into this region; he endeavored to minimise the risks as much as possible by taking up the longitudinal chain in sections, bit by bit, on the completion of the successive meridional chains, and thus apportioning it between several survey parties, each operating in the Terai for a short time, instead of assigning it to a single party to execute continuously from end to end, as all the other chains of triangles. But notwithstanding these precautions, the peril was great, and the mortality among both officers and men was very considerable; greater than in many a famous battle, says Mr. Clements Markham, in an eloquent passage in his Memoir of the Indian Surveys, in which he claims for the surveyors who were employed on these operations—with no hope of reward other than the favorable notice of their immediate chief and colleagues—merit for more perilous and honorable achievement than much of the military service which is plentifully rewarded by the praises of men and prizes of all kinds.

Everest retired in 1843, and was succeeded by Waugh, who applied himself energetically to the completion of the several chains of triangles exterior to the Great Arc, for which he obtained a substantial addition to the existing equipment of great theodolites. It was under him that the formidable longitudinal series through the Terai, which had been begun by Everest, was chiefly carried out. He personally initiated the determination of the position and heights of the principal snow peaks of the Himalayan ranges; and he did much for the advancement of the general topography of India, which had somewhat languished under his predecessor, who had devoted himself chiefly to the geodetic operations. He retired in 1861, and I succeeded to the charge of the Great Trigonometrical Survey. The last chain of the principal triangulation was completed in 1882, shortly before my own retirement.

Of the general character of the operations, it may be asserted without hesitation that a degree of accuracy and precision has been attained which has been reached by few and surpassed by none of the great national surveys carried out in other parts of the world and which leaves nothing to be desired even for the requirements of geodesy; a very considerable majority of the principal angles have been measured with the great 24-inch and 36-inch theodolite, and their theoretical probable error averages about a quarter of a second; of the linear measurements the probable error, so far as calculable, may be taken as not exceeding the two-millionth part of any measured length. And as regards the extent of the triangulation, if we ignore the primary network in Southern India, and all secondary triangulation, however valuable for geo-

*By Gen. J. T. Walker, C. B., LL.D., F.R.S., F.R.G.S., before the British Association for the Advancement of Science at Aberdeen, 1885.

graphical purposes, we still have a number of principal chains—meridional, longitudinal, and oblique—of which the aggregate length is 17,300 miles, which contained 9,230 first-class angles all observed, and rest on eleven base-lines measured with the Colby apparatus of compensation bars and microscopes. This prodigious amount of field-work furnishes an enormous mass of interdependent angular and linear measures; and each of these is fallible in some degree, for, great as was the accuracy and care with which they had severally been executed, perfect accuracy of measurement is as yet beyond human achievement; thus every circuit of triangles, every chain closing on a base-line, and even every single triangle, presented discrepancies the magnitude of which was greater or less according as derived from a combination of many, or only of a few, of the fallible facts of observation. Thus, when the field operations, were approaching their termination, the question arose as to how these facts were to be harmonized and rendered consistent throughout, which was a very serious matter considering their great number. The strict application of mathematical theory to a problem of this nature requires the adjustment to be effected by the application of a correction to every fact of observation, not arbitrarily, but in such a manner as to give it its proper weight, neither more nor less, in the final investigation, and in this the whole of the facts must be treated simultaneously. That would have involved the simultaneous solution of upwards of 4,000 equations between 9,230 unknown quantities, by what is called the method of minimum squares, and I need scarcely say that it is practically impossible to solve such a number of equations between so many unknown quantities by any method at all. Thus a compromise had to be made between the theoretically desirable and the practically possible. It would be out of place here to attempt to describe the method of treatment which was eventually adopted, after much thought and deliberation; I will merely say that the bulk of the triangulation was divided into five sections, each of which was treated in succession with as close approximation to the mathematically rigorous method as was practically possible; but even then the mass of simultaneous interdependent calculation to be performed in each instance was enormous, I believe greatly exceeding anything of the kind as yet attempted in any other survey. But the happy result of all this labor was that the final corrections of the angles were for the most part very minute, less than the theoretical problem errors of the angles, and thus fairly applicable without taking any liberties with the facts of observation. If the attribute of beauty may ever be bestowed on such things as small numerical quantities, it may surely be accorded to these notable results of very laborious calculations, which, while in themselves so small, were so admirably effective in introducing harmony and precision throughout the entire triangulation.

If now we turn once more to what Lambton calls "the sublime science of geodesy," which was held in such high regard by both him and Everest, we shall find that the great meridional arc between Cape Comorin and the Himalayas, on which they labored with so much energy and devotion, is not the only contribution to that science to which the Indian triangulation is subservient, but every chain of triangles—meridional, longitudinal, or oblique—may be made to throw light either on geodesy, the science of the figure of the earth, or on geognosy, the science of the earth's interior structure, when combined with corresponding astronomical arcs of amplitude. Thus each of the several meridional chains of triangles may be utilized in this way, as their prototype has been, by having latitude observations taken at certain of their stations to give meridional arcs; and the several longitudinal chains of triangles may also be utilized—in combination with the main lines of telegraph—by electro-telegraphic determinations of differential longitudes to give arcs of parallel. When the stations of the triangulation which are resorted to for the astronomical observations are situated in localities where the normal to the surface coincides fairly with the corresponding normal to the earth's figure, the result is valuable as a contribution to geodesy; when the normal to the surface is sensibly deflected by local attraction, the result gives a measure of the deflection which is valuable as a contribution to geognosy.

Having regard to these circumstances, I moved the Government to supply the Trigonometrical Survey with the necessary instruments for the measurement of the supplemental astronomical arcs; and as officers became available on the gradual completion of the successive chains of triangles, I employed some of them in the required determinations of latitude and differential longitude. It so happened that about the same time geodesists in Europe began to recognize the advantages to science to be acquired by connecting the triangulations of the different nationalities together, supplementing them with arcs of amplitude. The "International Geodetic Association for the Measurement of Degrees in Europe" was formed in consequence, and it has been, and is still, actively employed in carrying out this object; in India, however, the triangulation was complete and connected throughout, so that only the astronomical amplitudes were wanting. They are still in progress, but already meridional chains, aggregating 1,840 miles in length, and lying to the west of the Great Arc, have been converted into meridional arcs; and the three longitudinal chains, from Madras to Mangalore, from Bombay to Vizagapatam, and from Kurrachee *via* Calcutta to Chittagong, of which the aggregate length is 2,600 miles, have been converted into arcs of parallel. In the former the operations follow the meridional course of the chains of triangles; in the latter they follow the principal lines of the electric telegraph, which sometimes diverge greatly from the direction of the longitudinal chains of triangles, the two only intersecting at occasional points; the astronomical stations are therefore placed at the trigonometrical points which may happen to be nearest the telegraph lines, whether on the meridional or on the longitudinal chains, and their positions are invariably so selected as to form self-verificatory circuits which are usually of a triangular form, presenting three differential arcs of longitude; each of these arcs is measured independently as regards the astronomical work—though for the third arc there is usually no independent telegraph line but only a coupling of the lines for the first and second arcs—and this has been proved to give such an excellent check on the accuracy of the operations, that it is not too much to say that no telegraphic longitude operations are entirely reliable which have not been verified in some such manner.

Through the courtesy of Colonel Stotherd, Director-General of the Ordnance Survey, I am enabled to exhibit two charts, one of the triangulation of India, the other of that of Europe, which have recently been enlarged to the same scale in the Ordnance Survey Office at Southampton for purposes of comparison. The first is taken from the official chart of the Indian survey, and shows the great meridional and longitudinal chains and Lambton's network of principal triangles, the positions of the base lines measured with the Colby apparatus, the latitude and the differential longitude stations, the triangular circuits of the longitudinal arcs, the stations of the pendulum and the tidal operations which will be noticed presently, and the secondary triangulations to fix the peaks of the Himalayan and Sulimani ranges, and the positions of Bangkok in Siam and Kandahar in Afganistan, the extreme eastern and western points yet reached.

The chart of the European triangulation has been enlarged from one published by the International Geodetic Association of Europe; in it special prominence is given to the Russian meridional arc, which extends from the Danube to the Arctic Ocean, and is twenty-five degrees twenty minutes in length, and to the combined English and French meridional arc, twenty-two degrees ten minutes in length, which extends from the Balearic Island of Fomentera in the Mediterranean, to Saxavord in the Shetland Islands. The aggregate length of the meridional arcs already completed in India is about equal to that of the English, French, and Russian arcs, combined; but the longest in India is about one and one-half degrees shorter than the Russian. As regards longitudinal arcs, I believe the two which were first measured in India, and were employed shortly afterwards by Col. Clarke in his last investigation of the figure of the Earth, are the only ones which have as yet been deemed sufficiently accurate to be made use of in such investigations, though arcs of much greater length have been measured in Europe. It would be interesting, if time permitted, to set forth the salient points of divergence between the systems of the Indian and the European surveys; I will only mention that in the southern part of the Russian arc, for a space of about eight degrees from the Duna to the Dneister, a vast plain, covered with immense and almost impenetrable forests, presented great obstacles to the prosecution of the work; the difficulty was overcome by the erection of a large number of lofty stations of observation, wooden scaffoldings which were 120 and even as much as 146 feet high, to overlook the forest. In Indian forests, as the Terai on the borders between British and Nepalese territories, the stations were raised to a greater heights than 30 feet, or just sufficient to overtop the curvature, and all trees and other obstacles were cleared away on the lines between them; this was found the most expeditious and economical process. The stations were very substantial, with a central masonry pillar, for the support of a great theodolite, which was isolated from the surrounding platform for the support of the observer. The lofty Russian scaffoldings only sufficed for small theodolites, and they were so liable to shake and vibration, that the theodolites had to be fitted with two telescopes to be pointed simultaneously by two observers at the pair of stations, the angle between which was being measured.

All the modern geodetic data of the Indian survey that were available up to the year 1880 were utilized by Colonel A. R. Clarke, C. B., of the Ordnance Survey, in the last of the very valuable investigations of the Figure of the Earth which he has undertaken from time to time. It will be obvious that new data tend to modify in some degree the conclusions derived from previous data, for the figure of so large a globe as our earth is not to be exactly determined from measurements carried over a few narrow belts of its superficies. Thus thirty years ago it was inferred that the equator was sensibly elliptic—and not circular, as had been generally assumed—with its

major axis in longitude 15° 34′ east of Greenwhich; but later investigations indicate a far smaller ellipticity, and place the major axis in west longitude 8° 15′. More significant evidence of the influence of new facts of observation in modifying previous conclusions is furnished by the French nation standard of length, the metre, which was fixed at the ten-millionth part of the length of the earth's meridional quadrant, as reduced from the best geodetic data available up to the end of the last century; but it is now found to be nearly $\frac{1}{5000}$th part less than the magnitude which it is supposed to represent, the difference being about a hundred times greater than what would be considered an allowable error in an important national standard of measure.

The Indian survey has also made valuable contributions to geodesy and geognosy in an elaborate series of pendulum observations for determining variations of gravity, which throws light both on the grand variation from the poles to the equator that governs the ellipticity, and on the local and irregular variations depending on the constitution of the interior of the earth's crust. They were commenced in 1865 by Captain J. P. Basevi, on the recommendation of General Sabine and the Council of the Royal Society, with two pendulums, one of which the General had swung in his notable operations which extend from a little below the equator to within 10 degrees of the pole. Captain Basevi had nearly completed the operations in India, and had taken swings at a number of the stations of the Great Arc and at various other points near mountain ranges and coast lines, when he died of exposure in 1871 at a station on the high table-lands of the Himalayas, while investigating the force of gravity under mountain ranges. Major Heaviside swung the pendulums at the remaining Indian stations, then at Aden and Ismailia on the way back to England, and finally at the base station, the Kew Observatory. Afterwards they and a third pendulum were swung at Kew and Greenwich by Lieutenant-Colonel Herschel, who took all three to America, swung them at Washington, and then handed them over to officers of the United States Coast Survey, by whom they have been swung at San Francisco, Auckland, Sidney, Singapore, and in Japan.

The pendulum operations in India have been successful in removing from the geodetic operations the reproach which had latterly been cast on them, that their value has become much diminished since the discovery that the attraction of the Himalayan mountains is so much greater than had previously been suspected, that it may have materially deflected the plumb-line at a large number of the astronomical stations of the Great Arc, and injuriously influenced the observations. Everest considered the effects of the Himalayan attraction to be immaterial at any distance exceeding sixty miles from the feet of the mountains; but in his days the full extent and elevation of the mountain masses was unknown, and their magnitude was greatly under-estimated. Afterwards, when the magnitude became better known, Archdeacon Pratt of Calcutta, a mathematician of great eminence, calculated that they would materially attract the plumb-line at points many hundred miles distant; he also found that everywhere between the Himalayas and the ocean, the excess of density of the land of the continent as compared with the water of the ocean would combine with the Himalayan attraction and increase the deflection of the plumb-line northwards, towards the great mountain ranges, and that under the joint influence of the Himalayas and the ocean the level of the sea, Kurachee would be raised 560 feet above the level at Cape Comorin.

But as a matter of fact the Indian arc gave a value of the earth's ellipticity which agreed sufficiently closely with the values derived from the arcs measured in all other quarters of the globe, to show that it could not have been largely distorted by deflections of the plumb-line; thus it appeared that whereas Everest might have slightly underestimated the Himalayan attraction, Pratt must have greatly overestimated. His calculations were however based on reliable data, and were indubitably correct. For some time the contradiction remained unexplained, but eventually Sir George Airy put forward the hypothesis that the influence of the Himalayan masses must be counteracted by some compensatory disposition of the matter of the earth's crust immediately below them, and in which they are rooted; he suggested that the bases of the mountain had sunk to some depth into a fluid lava which he conceived to exist below the earth's crust, and that the sinking had caused a displacement of dense matter by lighter matter below, which would tend to compensate for the excess of matter above. Now Pratt's calculations had reference only to the visible mountain and oceanic masses, and their attractive influence—the former positive, the latter negative—in a horizontal direction; he had no data for investigating the density of the crust of the earth below either the mountains on the one hand, or the bed of the ocean on the other. The pendulum observations furnished the first direct measures of the vertical force of gravity in different localities which were obtained, and these measures revealed two broad facts regarding the disposition of the invisible matter below; first that the force of gravity diminishes as the mountains are approached, and is very much less on the summit of the highly elevated Himalayan table-lands than can be accounted for otherwise than by a deficiency of matter below; secondly, that it increases as the ocean is approached, and is greater on islands that can be accounted for otherwise than by an excess of matter below. Assuming gravity to be normal on the coast lines, the mean observed increase at the island stations was such as to cause a seconds' pendulum to gain three seconds daily, and the mean observed decrease in the interior of the Continent would have caused the pendulum to lose 2½ seconds daily at stations averaging 1,200 feet above the sea level, five seconds at 3,800 feet, and about twenty-two seconds at 15,400 feet—the highest elevation reached—in excess of the normal loss of rate due to height above the sea.

Pratt was strongly opposed to the hypothesis of a substratum, or magma, of fluid igneous rock beneath the mountains; he assumed the earth to be solid throughout, and regarded the mountains as an expansion of the invisible matter below, which thus becomes attenuated and lighter than it is under regions of less elevation, and more particularly in the depression and contractions below the bed of the ocean. And certainly we seem to have more reason to conclude that the mountains emanate from the subjacent matter of the earth's crust than that they are as wholly independent of it as if they were formed of stuff shot from passing meteors and asteroids; any severance of continuity and association between the visible above and the invisible below appears, on the face of it, to be decidedly improbable.

The hypothesis of sub-continental attenuation and sub-oceanic condensation of matter is supported by the two arcs of longitude on the parallels of Madras and Bombay; for at the extreme points of these arcs, which are situated on the opposite coast lines, the horizontal attraction has been found to be not landwards, as might have been anticipated, but seawards, showing that the deficient density of the sea as compared with the land is more than compensated by the greater density of the matter under the ocean than of that under the land.

While on the subject of the constitution of the earth's crust, I may draw attention to the circumstance that the tidal observations which have been carried on at a number of points on the coasts of India, as a part of the operations of the Survey, tend to show that the earth is solid to its core, and that the geological hypothesis of a fluid interior is untenable. They have been analysed by Prof. G. H. Darwin, with a view to the determination of a numerical estimate of the rigidity of the earth, and he has ascertained that whilst there is some evidence of a tidal yielding of the earth's mass, that yielding is certainly small, and the effective rigidity is very considerable, not so great as that of steel, as was at first surmised, but sufficient to afford an important confirmation of the justice of Sir William Thomson's conclusion as to the great rigidity.

The Indian pendulum observations have been employed by Colonel Clarke, in combination with those taken in other parts of the globe, to determine the earth's ellipticity. Formerly there was wont to be a material difference between the ellipticities which were respectively derived from pendulum observations and direct geodetic measurements, the former being somewhat greater than $\frac{1}{289}$, the latter somewhat less than $\frac{1}{290}$; but as new and more exact data became available, the values derived from these two essentially independent sources became more and more accordant, and they now nearly agree in the value $\frac{1}{293}$.

As a part of the pendulum operations, a determination of the length of the seconds' pendulum was made at Kew by Major Heaviside, with the pendulum which had been employed for the same purpose by Kater early in the present century, when leading men of science in England believed that in the event of the national standard yard being destroyed or lost, the length might be reproduced at any time with the aid of a reversible pendulum. In consequence of this belief an Act of Parliament was passed in 1824 which defined the relations between the imperial and the seconds' pendulum, the length of the former being to that of the latter—swung in the latitude of London, in a vacuum and at the level of the sea—in the proportion of 36 inches to 39.1303 inches. Thus, while the French took for their unit of length the ten-millionth part of the earths' meridional quadrant, the English took the pendulum swinging seconds in the latitude of London. In case of loss the yard is obviously recoverable more readily and inexpensively by reference to the pendulum than the meter by reference to the quadrant; it is also recoverable with greater accuracy; still the accuracy is not nearly what would now be deemed indispensable for the determination of a national standard of length, and it is now generally admitted that every pendulum has certain latent defects, the influence of which cannot be exactly ascertained. Thus the instrument cannot be relied on as a suitable one for determinations of absolute length; but, on the other hand, so long as its condition remains unaltered, it is the most reliable instrument yet discovered for differential determinations of the variations of gravity. In truth, however, the pendulum is a very wearisome instrument to employ even for this purpose, for it has to be swung many days and with constant care and attention to give a single satisfactory determination; thus if such a thing can be invented and perfected as a good differential

gravity-meter, light and portable, with which satisfactory results can be obtained in a few hours, instead of many days, the boon to science will be very great.

The trigonometrical operations fix with extreme accuracy two of the co-ordinates—the latitude and longitude—which define the positions of the principal stations; but the third co-ordinate, the height, is not susceptible of being determined by such operations with anything like the same degree of accuracy, because of the variations of refraction to which rays of light passing through the lower strata of the atmosphere are liable, as the temperature of the surface of the ground changes in the course of the day. In the plains the apparent height of a station ten to twelve miles from the observer has been found to be upwards of 100 feet greater in the cool of the night than in the heat of the day, the refraction being always positive when the lower atmospheric strata are chilled and laden with dew, and negative when they are rarefied by the heat radiated from the surface of the ground. At hill stations the rays of light usually pass high above the surface of the ground, and the diurnal variations of refraction are comparatively immaterial, and very good results are obtained by the expedient of taking the vertical observations between reciprocating stations at the same hour of the day, and as nearly as possible at the time of minimum refraction; but in the plains this expedient does not usually suffice to give reliable results. The hill ranges of central and those of northern India are separated by a broad belt of plains, which embraces the greater portion of Sind, the Punjab, Rajputana, and the valley of the Ganges, and is crossed by a very large number of the principal chains of triangles, on the lines where the chart shows stretches of comparatively small triangles, which are in most instances of considerable length. Thus it became necessary to run lines of spirit levels over these plains from sea to sea, to check the trigonometrical heights. The opportunity was taken advantage of to connect all the levels which had been executed for irrigation and other public works, and reduce them to a common datum; and eventually lines of level were carried along the coast and from sea to sea to connect the tidal stations. The aggregate length of the standard lines of level executed up to the present time is nearly 10,000 miles, and an extensive series of charts of the levels derived from other departments of the public service and reduced to the survey datum has already been published.

The survey datum which has been adopted for all heights, whether deduced trigonometrically or by spirit-leveling, is the mean sea level as determined, either for initiation or verification by tidal observations at several points on the coast lines. At first the observations were restricted to what was necessary for the requirements of the survey, and their duration was limited to a lunar month at each station. In 1872 more exact determinations were called for, to acertain whether gradual changes in the relative level of land and sea were taking place at the head of the Gulf of Cutch, as had been surmised by the geological surveyors, and observations were taken for over a year at three tidal stations on the coasts of the gulf, to be repeated hereafter when a sufficient period had elapsed to permit of a measurable change of level having taken place. Finally, in 1875, the Government intimated that as "the great scientific advantages of a systematic record of tidal observations on Indian coasts had been frequently urged and admitted," such observations should be taken at all the principal ports and at such points on the coast lines as were best suited for investigations of the laws of the tides. In accordance with these instructions, five years' observations have been made at several points, and new stations are taken up as the operations at the first ones are completed.

LITERATURE.

Review of the Foreign Engineering and Industrial Press.

[Specially Translated and Prepared for ENGINEERING NEWS.]

Annales des Ponts et Chaussées.—M. Fiamant who was commissioned by the Minister of Public Works to investigate the resistance of steel and iron, and who visited the principal works in France and Belgium for that purpose, continues an exhaustive article on the subject. Steel is as yet but little used in France for bridges. A long notice on Life and Works of M. Colignon, Inspector General of Ponts et Chaussées gives an interesting insight into the life of an engineer some fifty years ago. The very course of studies then followed in the Ecole Polytechnique was limited in range and few of the works and publications that are now so abundant, were to be had. Colignou was the first to make use of compressed air for deep sea foundations. He also carried out the great network of Russian railways began after ths Crimean War. He was born in Metz 1802 and died last year in Paris. The article of M. Leygue on "Piers and structures of great height and the choice between Masonry and Metal" is quite a treatise.

Moniteur Industriel.—The Paris Municipal Council has decided in favor of having pneumatic tubes laid in the sewers. M. V. Popp, a civil engineer is to have the concession for forty years.

M. Stoop, engineer, is sent to this country by the Netherland government to study the petroleum field both here and in Canada. There seems to be a belief that good oil can be found in Java and Samatra.

M. de Lesseps, in a recent report to the Académie des Sciences gave some particulars of the work doing in the way of reclaiming the Tunisian Sahara by Commandant Landas. The idea of making a great interior sea is not abandoned, although Col. Roudaire, its first projector is dead. In journeying last year through the province of Gabes, M. Landas was struck with the many vestiges of Roman civilization—principally aqueducts for irrigation purposes. An artesian well which he had bored, gives 9,000 litres per minute. A small colony has been already established, and doubtless further work will be soon pursued. It is believed that there are many subterranean rivers in this part of Africa.

The authorities of the city of Brussels are at present considering two plans for supplying the city with water One proposes to take the water from the Meuse, above Namur; the other from the junction of the Demer, and the Dyle. The quantity required is 300,000 cubic metres a day.

There will be no surface crossings allowed any longer on the Paris Belt road. The necessary works for doing away with them are to be begun at once.

The opening of the Saint Gothard tunnel has undoubtedly been very prejudicial to the general trade of France, and especially to that of the port of Marseilles. The tonnage of Genoa has increased from 1,263,000 in 1881 to 1,890,000, in 1885—equivalent to 50 per cent. An engineer, commissioned by the government, advises the building of a line from Dijon to Brussels and Antwerp, *via* Bar-Sur-Aube, or a rectification of the present lines *via* Chaumont, Mezières and Namur.—this latter would lessen distance by 110 kilometres. That by Dijon, Rocroy, etc., would save 186 kilometres, and beat the Gothard by 110 kilometres. In the meantime the projects of the Simplon and the Saint Bernard, are again being discussed. The project of M. Aguido for the Simplon comprise a cable, locomotive, and short tunnel at high altitude, but is greatly objected to, as no such system could satisfy a large traffic and in such a climate.

Centralblatt der Bauverwaltung.—A nicely illustrated, but short article, treats of beton works, and especially beton bridges. The German manufacturers of Portland cement are becoming inordinately proud, lately, of their ability to turn out superior products. The grand necessity in such constructions, especially for bridges, is to have the beds for the beton parts perfectly immovable. The writer, Baurath Rheinhard, of Stuttgart, claims that such bridges are elastic. It is very essential to keep the made beton parts wet during eight days after making, especially during warm weather. An article on General Wrede's clinometer, or batter level, which has been greatly improved in Norway, is said to have saved the state many thousands of dollars. Its advantages are mostly seen in finding a street or road line in the field. By the Norwegian system, the ground strips on which the polygon line is marked out, can be found at once in the field, and there approach very closely the actual road line. We may, perhaps, reproduce this illustrated article in a future issue.

Zeitschrift der Oest Ing. Ver.—Inspector-General Baron Gostkowski has a long article on brakes. Although all the formulæ are not given in the present issue, the writer concludes that the handbrakes on the Austrian lines do not exert the necessary pressure in proportion to weight of car. Iszkowski continues his "observations as to the indications afforded by the characteristic signs of river basins as to the minimum, normal and maximum quantities of water." Of course, the subject covers a vast field of observation, and the variation of a co-efficient must be found in the nature of the soil and vegetation; the extent of the rainfall in the vicinity of sources, and the distribution of this latter. He gives tabulated results from 289 points, comprising the principal rivers of Europe.

The Austrian engineers and architects are not satisfied with the views of the government as to the duties of "stone masons and carpenters." Then there are "well masters," who are allowed to lay pipes—in the primary acceptation of the term. Professor Heyne, the Technical High School in Graz, supplies a "Contribution to Hydrography and Physical Geography." The formulæ of the wear of alluvial matters carried away in rivers, are certainly numerous, and are connected, of course, with the deepening of running waters.

They are beginning to complain in Saxony that the low renumeration of civil engineers and architects in that State have had at last some influence on the Economic *Deutsche Judend*, and there is now a positive dearth of the sprouting engineer.

Eisen Zeitung.—It would seem that the small gauge "forest" railroad is beneficial in German forests, according to "master foresters" Sprengel who lately informed the Natural History Union at Aix la Chapelle that such roads were largely promotive of the lumber business.

Giornale dei Lavori Pubblici (Rome). Italy is exerting herself to increase foreign exports, quite outside of our own saddle colored importations. In the last issues of the above, both the new English, and the Russian railway tariff bills are considered at length. The total length of the new complementary Sardinian lines is only 583 Kilometres. Among the contractors are two Belgium firms.

Le Genie Civil.—"Lighting the Hippodrome by Electricity," "Railroad Legislation in Brazil," and several important articles on electrical subjects, etc., are among the contents of the latest numbers.

Rivista di Artiglieria e Genio.—A voluminous article with many illustrations, is devoted to the new military barracks in Rome. "New Methods of Determining Problems in Firing," is by Major Siacci. "Mathematics in Military Art," is a resumé of Galileo's views and is accompanied by an autograph letter of that famous man. The remaining articles are interesting to military engineers and artillery officers.

Recent Locomotives. Illustrations, with Descriptions and Specifications and Details, of Recent American and European Locomotives. Reprinted from the *Railroad Gazette*. Enlarged Edition, 1886; *Railroad Gazette* publisher, N. Y. Price, $3.50.

This profusely and handsomely illustrated volume is without doubt the best treatise on American locomotive building extant; for the material here presented in over 500 illustrations and the pages of specifications and explanatory text, includes the very latest practice both in America and abroad. The later additions especially are detail drawings, with scale or dimensions given, and comprise all the features of the engines. The final chapter is devoted to the compound engine, and illustrates the latest forms and describes the principle in greater detail than in any other English work at least. This work should be in the hands of every American interested in the building or running of locomotives; and it is the best investment which we could possibly recommend to our foreign cousins who are really interested in the improved efficiency of their rolling stock and increased dividends, consequent on the use of American-built engines.

Hydraulics. The Flow of Water through Orifices, over Weirs and through Open Conduits and Pipes. By HAMILTON SMITH, JR., Mem. Am. Soc. C. E., and Am. Inst. of M. E., New York, John Wiley & Sons, 1886, 12x10 inch pp. 362. Price, $8.00.

This latest contribution to the literature of hydraulics is practically a careful exhibit, summation and comparison of results as obtained by the best authorities of all nations. To these the author adds original experiments and final conclusions which also possess a fair claim for originality inasmuch as many of them differ from the previously published views on hydraulics.

The introductory chapter on "nomenclature" is a novelty in similar works worthy of special note; for in it the author starts all readers fairly by specifically stating just what he means by the symbols used hrough out the text, instead of assuming, as is too

often the case, that with some of them at least the student *must* be well-informed. As the work is primarily intended for English readers, all dimensions from foreign authorities are reduced to English measures and all temperatures to the Fahrenheit scale. And in addition to this Mr. Smith has almost exclusively consulted the original authorities and original editions of these, and has not unfrequently discovered errors of typography or reductions of the author, which he has corrected.

The scope of this publication can be better understood by setting out the chapter heads, as follows: I. Properties of Water. II. Theory of Hydraulics. III. Flow through Orifices. IV. Velocity of Approach. V. Flow over Weirs. VI. Flow over Weirs and through Orifices compared. VII. Flow through Open Conduits. VIII. Flow through Pipes. IX. Experiments with Orifices and Weirs in California. X. Experiments of Flow through Pipes. XI. Experiments with Orifices. Corrections and Notes.

Under the above heads the authorities used are in each case carefully noted, with references to their published theories and results in copious foot notes. The diagrams of comparative results and the illustrations of apparatus are very handsomely shown, and we might here say as much of the general typography and tabular works. The experiments by the author on the riveted wrought-iron water-pipe used in California are especially interesting to engineers as relating to a form of pipe not familiar to the profession generally. Though it would hardly come within the province of the title, we regret that nothing has been said concerning the duration and general behavior of this California pipe, while the author was on that subject.

As an intelligent and careful summation of formulæ and results this new work should be an acceptable addition to the important literature of hydraulics.

Transactions and Proceedings, American Society of Civil Engineers, July, 1886.

CONTENTS.—Address at the Annual Convention at Denver, Col., by Henry Flad, President. "On the strength of Columns discussing the Experiments which have accumulated and proposing New Formulæ"; by Thos. H. Johnson; "Discussion on Columns," by James Christie and Thos. H. Johnson. "New Formula for Compression Members," by R. Krohn.

NEW PUBLICATIONS RECEIVED.

Rain Gauge Investigations. By E. B. WESTON, C. E., Providence, R. I. Reprint from the American Meteorological Journal of June, 1886.

One Hundred Proofs that the Earth is not a Globe! By WM. CARPENTER, Referee, etc. "Upright, Downright, Straightforward," Baltimore, Md., 1885. Printed and published by the author, 71 Chew street. Price, 25 cents. 4th edition, 8 vo. pamphlet, 28 pages.

From Cassell & Company. This enterprising English publishing company has entered the field with a cheap library and have already issued twenty-four numbers of which the following have been received: 1. *My Ten Years' Imprisonment*, by SILVIO PELLICO. 2. *Childe Harold's Pilgrimage*, by LORD BYRON. 3. *Autobiography of Benjamin Franklin.* 4. *The Complete Angler*, by ISAAC WALTON. 5. *The Man of Feeling*, by HENRY MACKENZIE. 6. *The School for Scandal* and *The Rivals*, by RICHARD BRINSLY SHERIDAN. 7. *Sermons on the Card and other Discourses*, by BISHOP LATIMER. 8. *Plutarch's Lives of Alexander & Cæsar.* 9. *Castle of Otranto.* 10. *Voyages and Travels*, by SIR JOHN MANDEVILLE. 11. *She Stoops to Conquer* and the *Good Natured Man*, by OLIVER GOLDSMITH. 12. *The Adventures of Baron Trench.* 14. *Lady of the Lake*, SIR WALTER SCOTT. 15. *Selections from Table Talk of Martin Luther.* 16. *Wisdom of the Ancients*, by LORD BACON. 17. *Francis Bacon*, by LORD MACAULEY. 18. *Lives of the English Poets, Waller, Milton and Cowley.* 19. *Thoughts on the Present Discontents and Speeches.* 20. *Battle of the Books.* 21. Poems, by GEO. CRABBE. 22. *Herodotus Egypt and Syria.* 23. *Hamlet.* 24. *Voyager's Tales*, RICHARD HAKLUYT. These volumes from "Cassell's National Library." They are issued weekly at ten cents each or $5.00 per year; they make volumes of about 200 pages, 3¾" by 5½", a very handy size for the pocket; the type is clear and is set leaded, and the volumes are well printed and neatly bound. They are edited by Prof. Henry Morley, and the aim is to publish in a cheap and accessible form, the best of English literature.

MORE REMARKABLE SPRINGS.—Reports from Cuba state that several springs have recently burst forth near Havana; and a considerable lake three feet deep is already formed and is threatening the village of Ceibadelagua with inundation. Several plantations are now submerged.

Thomas Paine as the Inventor of Iron Bridges.

In speaking of Thomas Paine, the political and deistical writer, we are apt to forget that among the many paths in life he followed, as preacher, teacher and soldier, a power in the political world and so-called atheistical author whose writings have been object an of vituperation rather than controversy, he was also an engineer, a designer of iron bridges. His evidence upon the latter subject, especially in regard to the origin of the invention of iron bridges, is interesting to Americans.

Biographers simply tell us that he invented an iron bridge in 1787; but Paine himself in 1803 writes out the story* and we can do no better than to give his memoir in his own words as follows:

"As bridges and the methods of constructing them are becoming objects of great importance in the United States, and as there are at this time proposals for a bridge over the Delaware and a bridge beginning to be erected over the Schuylkill at Philadelphia, I present the public with some account of the construction of iron bridges."

From the memoir introduced as above we make the following extracts:—"As America abounds in rivers, * * I turned my attention after the revolutionary war was over to finding a method of constructing an arch, that without rendering the height inconvenient or the ascent difficult might extend at once from shore to shore over rivers of 300 or 500 feet and probably more * * *. The principle I took to begin with and worked upon was that the small segment of a large circle was preferable to the great segment of a small circle. The architects I conversed with in England denied the principle; but it was generally supported by mathematicians and experiment has now demonstrated the fact.

"In 1786, I made three models, partly at Philadelphia but mostly at Bordentown in the State of New Jersey. One model was in wood, one in cast-iron and one in wrought-iron, connected with blocks of wood representing cast-iron blocks; the principle of all was the same as that of the small segment of a large circle.

"I took the last mentioned one with me to France in 1787 and presented it to the Academy of Sciences in Paris for their opinion upon it. The Academy appointed a committee of three of their own body, M. Le Roy, the Abbe Bosson and M. Borde, the last two celebrated mathematicians. I presented it as a model for a bridge of a single arch of 400 hundred feet over the river Schuylkill in Philadelphia. The committee brought in a report, that the Academy adopted, that an arch on the principle and construction of the model might in their opinion be extended 400 feet, the extent proposed."

In September of the same year the model was sent to Sir Joseph Banks, President of the Royal Society in England. Paine then had made a complete arch rib of 90 feet span and 5 feet height from chord line to the center of arch; this was cast at the foundry of Mr. Walkers at Rotheram. It was a segment of a circle of 410 feet diameter and was erected between the walls of a furnace and the gable end of a brick building which served as abutments. The rib weighed three tons and they loaded it with double its weight in pig-iron. A description of the experiment being sent to Sir Joseph Banks, he wrote in answer, "I look for many other bold improvements from your countrymen, the Americans, who think with vigor and are not fettered with the trammels of science, before they are capable of exerting their mental faculties to advantage."

On the success of this experiment Paine had the same founders cast and manufacture a complete bridge of five ribs of 110 feet span and five feet rise, they being a segment of a circle of 610 feet diameter, and sent it to London as a specimen for establishing a manufactory of bridges to be sent to any part of the world.

At this point in his career as a bridge builder he was drawn off by his interest in the French Revolution. He says, "During my residence in France, which was from 1792 to 1802, an iron bridge of 236 feet span and 34 feet rise was erected over the river Wear in Sunderland, County of Durham, England. It was done chiefly at the expense of the two members of parliament from that county, Milbanke and Bourdon."

A friend of Paine's wrote to Milbanke supposing that the constructors of the Sunderland bridge had made free with Paine's model which was at the iron works where the Sunderland bridge was cast. Mr. Milbanke writes, "With respect to my bridge over the river Wear at Sunderland, it is certainly a work deserving of admiration, both from its structure and utility. And I have good grounds for saying that the first idea was suggested by Mr. Paine's bridge exhibited at Paddington. What difference there may be in some part of the structure or the proportions of wrought and cast-iron I cannot pretend to say, Bourdon having undertaken to build the bridge, * * * with respect therefor to any gratuity to Mr. Paine, though ever so desirous of rewarding the labor of an ingenious man, I do not feel how, under the circumstances already described above, I have it in my power, having nothing to do with the bridge after the payment of my subscription. But if you can point out any mode according to which it should be in my power to be instrumental in procuring him any compensation for the advantages the public may have derived from his ingenious model, from which certainly the outline of the bridge at Sunderland was taken, be assured it will afford me great satisfaction."

Paine in his memoir of 1803 proposed that Congress erect an experimental arch of 400 feet span, to be the segment of a circle of at least 1,000 feet diameter and to let it remain exposed to public view so that the method of constructing such arches may be generally known, and he offers to furnish the proportions for the several parts of the work and to give his attendance to superintending the erection of it freely. He finally requests that his memoir be put upon the journals of Congress as an evidence hereafter "that this new construction of bridges originated in America."

*See Political Works of Thomas Paine: William Dugdale, London, 1844.

THE BELLEPLAINE WELL.—The artesian well at Belleplaine, Ia., referred to last week, is still spouting. The correct story of this remarkable well is about as follows: The boring tools struck water at a depth of 193 feet, about 40 feet nearer the surface than it was found in several other wells in the same region. The water rose in a solid stream, in a 2-inch hole, 12 feet above the surface, and the whole rapidly increased in size. A 3-inch casing was then forced down 120 feet, but the flow outside the casing soon became unmanageable and the well contractor abandoned his job. Within three days the hole was a yard wide at the surface and the water was rising 4 feet above the surface, thick with sand. A 15-inch casing tube was next driven down about 80 feet but the water still came up outside this tube. By this time all the other wells in the town had ceased flowing. Finally a 2-inch tube was sunk 210 feet as a guide, and a cone 30-inches in upper diameter and weighing over a ton was sunk to a depth of 62 feet. But the flow is still as great as ever, and the street has been transformed into the bed of a stream to prevent overflow on adjoining property.

PITTSFIELD, MASS.—The water commissioners have raised the dam at Ashley lake 2½ feet, a change which will give storage for 60,000,000 gallons of water additional.

ENGINEERING NEWS

AND

AMERICAN CONTRACT JOURNAL.

TRIBUNE BUILDING, - NEW YORK CITY.

THE ENGINEERING NEWS PUBLISHING CO. PROPRIETOR.

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IN view of the recent calamitous earthquake and the very positive theories of sundry geologists concerning its cause and its relation to the interior of the earth's crust, and also the theories concerning the nature of the earth's core, some of the closing paragraphs of the paper in the Trigonometrical Survey of India, published this week, cannot fail to be of special interest at this time. In connection also with this very valuable paper, we are sure that every land surveyor will be prouder than ever of a profession which is full of such grand possibilities in the field of science.

PHILADELPHIA COUNCILS have been for some years discussing the erection of a permanent bridge across the Schuylkill river at Market street, in that city, to replace the temporary, and now unused, wooden structure which was hastily erected in 1875 after the original bridge was burned down.

Various plans have been proposed, including an all stone arched structure on stone and concrete piers. The stone project was abandoned owing to its excessive cost and the difficulties of foundation and flatness of arch required, and a steel and iron bridge resting upon the old foundations put down in the first decade of this century is now seemingly determined upon.

City Councils sometime ago awarded this last contract to Mr. R. A. Malone & Sons, of Lancaster, Pa., at a sum of $271,000 for the work complete; but the bill was vetoed by Mayor Smith with the rather strange reason given that the specifications admit changes in design by the Chief Engineer, without limit in amount and without the approval of Councils. As the total appropriation for the bridge is $300,000, and is limited to that expenditure, the balance of $29,000 does not seem to be an excessive margin to leave to the discretion of the City Engineer, in a structure of this character.

The City Councils of Philadelphia, at their meeting of September 6, seemed to think that the Mayor's reasons were not well taken, and after some sharp debate passed the original bill by a vote of 65 to 3 in Common Council, and 23 to one in Select Council. The contract with R. A. Malone & Sons is thus ratified and we may expect work to be commenced at once.

Owing to the very mixed state in which the bridge project has been floating for a long time we have refrained from giving any plans; but will do so now as soon as they can be prepared.

WE notice a rather too rapid development in the size and conspicuous character of the advertising signs about the station platforms of the New York elevated railways. Even to the every-day traveler a station sign is a very useful thing to find when he looks up hastily from his newspaper with the purpose of ascertaining his whereabouts; and to the stranger this sign is very important. But the disgust of the one and the bewilderment of the other in finding himself confronted by a glaring enameled poster setting forth the merits of "Castoria," or some other nostrum, is better imagined than described.

In England this feature of railway advertising has become an unmitigated nuisance; and at almost every halting place in the United Kingdom the usually very modest station sign is smothered out of sight entirely by great boards advertising "Coleman's Mustard," "Encore Whiskey" or the rival bill-posting firms of "Willing" and "Partington," among others. There the evil has taken such firm root that it is now almost impossible to eradicate it; but with us it has not yet assumed such a formidable shape, and some regulation should be adopted while there is yet time.

If the managers of our elevated roads can not forgo the profits to be derived from this business, we would respectfully suggest that they wash off the grime which now generally hides the name proper of the station and adopt some distinctive and conspicuous color for their own signs, and strictly forbid the use of this color by other parties about their premises. At present the advertisers evidently aim to make their signs as much like the one the traveler is looking for as possible, with the purpose of swindling the innocent seeker after knowledge into reading them. But if the sign proper was distinctive in color, this trick of the trades would be somewhat less of a nuisance, and the passenger would stand a better chance of finding what he wanted.

THE Russians seem to be pushing their railroad enterprises in far-off Turkestan with something akin to American energy. Within two weeks they have crossed the Murghab river at Merv, very near the Afghanistan border; and from there will complete the line northeastwardly to Charjui on the river Oxus, a distance of about 170 miles further. This latter length they expect to finish in November next.

With the road to Charjui completed, the Russians will have an all-rail line extending from the Caspian sea about 900 miles eastward, well into the heart of Central Asia. From Merv, just north of the Afghanistan border, to the Bolan Pass, on the southern boundary, is about 700 miles as the crow flies. But as Kandahar, towards which point the Indian railways are now being pushed through the Bolan Pass, is 200 miles nearer, we can say that but 500 miles of road must yet be located to connect the Caspian sea with the Indian Ocean.

It must be said, however, that the construction of this missing link of railway will be difficult and very expensive work, if we can judge from the latest published maps of Afghanistan; for the line will have to cross the mountainous water-shed dividing the rivers of the Indian ocean from those flowing into the Caspian and northward; and these mountains are high and abrupt and the various ranges cover a wide extent of country.

It is to be sincerely hoped that both the English and the Russians will confine their rivalry to the opening up to commerce of this rich but little-known country. The cost of a war would build many railroads, if the ambitious and jealous leaders of these two nations could only be made to see it that way. And as the railroad is the most powerful agent of modern times in civilizing the semi-barbarians who now control and limit the traffic from these countries; the Russians need their roads to complete the conquest of Turkestan, just as the English deem their's the most potent factor in transforming India into a productive market. So let both nations push forward the good work; the world will be the gainer in the end.

THE London *Mechanical World*, referring to the statement of Mr. Richard Moon, Chairman of the London and North Western Railway, that by the reduction of first-class fares and the extension of third-class passenger facilities, the receipts of that road, notwithstanding an increase of five million passengers, had fallen £5,000; which difference he asserted "had come out of the pockets of the shareholders and gone into the hands of what he might call an ungrateful public," suggests "The working arrangements of the line may be responsible for much more than the £5,000 loss."

We are glad to see a growing interest in the losses the English investing public suffer through the continued use of rolling stock of the English pattern on their railways. As a late number of the *Engineering and Mining Journal* has shown, 550 American locomotives of equal efficiency with those in use on the Pennsylvania road, could do all of the service now performed by the 2,476 locomotives employed by the London & North Western, with a saving in the items of repairs and renewals, of $840,000 per annum. As the London & North-Western could doubtless borrow the money necessary to buy these 550 locomotives, say $5,500,000, at four per cent. interest, it would save $620,000 annually by giving or throwing away its 2,476 locomotives and buying others in this country.

The Pennsylvania road, as its reports show has reduced its freight charges from three and three-quarter (3¾) cents per ton mile in 1855, to three-quarters (¾) of one cent in 1884, during which time the railways of England have made a reduction of about ten per cent. only in their freight charges; under these circumstances it is safe to assume that the purchase of American locomotives by the London & North Western would allow a still further reduction of passenger fares with a corresponding reduction of freight rates and still leave a large margin for increased dividends.

Now, while nearly all, if not all, English roads are reducing their dividends, notwithstanding the fact that their freight charges are maintained at such prohibitive rates as seriously to interfere with the industries of the country, we hope British investors will demand a careful investigation of the merits of the locomotives of the two countries and insist on the acceptance of the most economical machine.

The purchase of 550 locomotives in this country by the London & North-western, or any other railway company, would be a graceful act of international trade which would largely increase the aggregate of England's imports and exports, and could hardly fail to strengthen the friendly feelings now obtaining between the two countries. As a branch of our government has already set a good example by freely purchasing British plans for our war ships, we hope that no insular prejudices will be allowed to stand in the way of a proceeding, promising mutual benefits, and offering increased income to English capital while it will notably reduce the charges on all distribution throughout the United Kingdom.

Wrought-Iron *vs.* Cast-Iron Water-Pipes.

A correspondent asks our opinion as to the comparative merits of wrought-iron and cast-iron pipes for water service. In the light of all available data, we would say that no comparison can be made between the two; and we do not hesitate to recommend cast-iron for all water-works, if the engineer, builder and user of the works deems his peace of mind as worthy of consideration.

Cement-lined wrought-iron pipe has been used, in a number of places, and when the work is honestly done is reported to have given satisfaction. But we know too that very much of this pipe has been replaced by cast-iron at a cost far exceeding what would have been expended, had cast-iron been employed originally. Under very light static heads and in situations not exposed to pump-shock or water-ram action, light wrought-iron pipe can be used when economy of cost is the prime motive. But even then it must be firmly bedded, well jointed and well protected from corrosion by cement or other preservative compounds carefully applied.

In the hydraulic mining projects of the Pacific coast, riveted wrought-iron pipe has been used for more than twenty years, and at times with diameters up to 40 inches and under excessive pressure, reaching heads of 1,700 feet. But in these cases they were first employed simply because cast-iron mains of the required dimensions could not be transported into the mountains and ravines where these pipes are used. And the wrought-iron is thick enough to withstand the bursting pressure applied, and it is securely riveted.

The lasting qualities of the Pacific pipe has been somewhat of a puzzle to hydraulic engineers. They were all carefully coated originally with Smith's compound inside and out; but Mr. Hamilton Smith, C. E., who has had much experience in their use, and other competent authorities, state that after years of use these pipes show a smooth inside surface almost absolutely free from rust. In these pipes, for all thickness of plate under ⅜-inch, a lap-joint has been found advisable, double riveted on the longitudinal seam and single-riveted on the cross-seam. The usual joint is of the stove-pipe type, one end of the 20 feet length of pipe being made slightly larger than the other. In a pipe of this description, with plate testing to 50,000 pounds tensile per square inch, the ultimate strength of the riveted pipe is put at 35,000 pounds.

As showing the confidence of California engineers in this type of wrought-iron pipe, we might mention the following examples: In the Spring Valley Water-Works, one pipe is noted as being subjected to a strain of 20,000 pounds per square inch; with other pipes in the same works are under strains ranging from 11,600 to 13,100 pounds. The total length of pipe is seven miles; the maximum head is 1,720 feet, and they have been in use for about fifteen years. The Pacific Coast engineers seem to consider 14,000 pounds per square inch as a safe strain limit; but we notice that they recommend the wasting of water at the lowest points of an undulating main rather than the attempted saving of the volume by using stops or gates.

As to the cost of the California pipe, we have no certain data, but from ultimate figures, judge that there is little if any economy over cast-iron where conditions of transport are equal. The city of San Francisco has but lately completed a series of wrought iron mains of 48 inches diameter, and has others in contemplation. On this subject we should be glad to have some further light from our Pacific Coast readers.

But on our eastern coast and in the Mississippi valley the conditions of the production and transport of water pipe are very dissimilar from those just referred to. And we seriously doubt either the economy or comparative life and efficiency of even the best made wrought-iron pipe as compared with cast-iron. And, as before mentioned, we certainly do not recommend the substitution of the cheap types of cement-lined or riveted pipe for cast-iron; except as a temporary make-shift — that will very probably give trouble—until a more lasting and stronger material can be used.

Experiments are now in progress in Pittsburg, Pa., for the manufacture of lap-welded steel pipe up to diameters of 16 inches. The trial has as yet not proved a perfect success; pipes are rolled which are very light in weight and yet have comparatively enormous tensile strength, but the product lacks uniformity. These pipes are intended for conveying water and natural gas; but for the first use their life will depend greatly upon the lasting merits of the protective compounds used. They would be connected with screw or flanged joints and would undoubtedly be a very useful pipe.

The Proposed Intercepting Sewers and Sewage Disposal, of Providence, R. I.

The report of City Engineer Samuel M. Gray, on the location and size of the main and intercepting sewers of Providence, R. I., is at hand as presented to the City Council this week. The document is accompanied by numerous profiles and a plan of the city.

The general plan of the scheme shows the lines of intercepting sewers (total length 65,315 feet) skirting the city water front on the Providence and Seekonk rivers and following the lines of the two main valleys which intersect the city, and mark out the natural drainage of that area. The report fully explains the reasons for certain deviations and short cuts.

The plan also shows the lines of main sewers that would be required if a system of disposal by sewage irrigation was adopted terminating either at Seekonk Plains, or Warwick. The first scheme would command an area of about 1,175 acres, east of the city and across the Seekonk river, with an elevation of about 80 feet above high tide. A large part of this area is swampy land, however, which would require extensive draining before it could be utilized. The distance from the pumping station at India Point, at the south end of the city, to the northern end of the irrigation tract, is 5.085 miles; and Mr. Gray estimates that three 48-inch mains would ultimately be required to deliver the maximum volume of sewage; he included only one main, however, in his estimate of coast for the present.

The estimated cost of the Seekonk Plains plan for 100,000 people, and including main intercepting sewers with all necessary fittings, pumping machinery and station land and right of way, one 48-inch force main, and drainage and pipe distribution on farm, is $4,727,763. One of the advantages of this location is that it is also the most available land for the disposal of the sewage of Pawtucket, should that city ever decide to employ the irrigation or filtration method.

The Warwick plan includes the disposal of the new sewage by irrigation at a point 5.008 miles south of the pumping station at India Point, or nearly eight miles to the extreme southern end of the 2,216 acres best adapted to the purpose of filtration or irrigation; the highest point on the available territory is 64 feet above mean high water.

The estimated cost of the Warwick plan for 100,000 people, and including nearly the same character of items as enumerated above, is $4,879,847.

The float experiments of 1883 show that if the sewage was to be discharged in a crude state at Fields Point, which is just at the mouth of the Providence river, it would be brought back into the harbor by the flood tide, diluted of course but penetrating to all points and spreading out over the shallow waters. To carry the sewage away from this point it would be necessary to construct a reservoir capable of holding, say nine hours flow, to be discharged in one and one-half hours on the first part of the ebb tide. The estimated cost of this method of crude disposal including all intercepting sewers, as in the Warwick Plan, station and pumping machinery, land, conduit, reservoir, etc., is $3,730,022.

These estimates include construction only in each case and do not show the relative cost of pumping or maintenance. The Seekonk and Warwick plans of irrigation or filtration will involve a large addition to the annual cost of pumping over the expense of pumping into precipitation tanks on the method recommended by Mr. Gray and to be further referred to. The same statement is true of the crude disposal plan which also involves some future plan of utilization or other disposal.

Mr. Gray then proceeds to state his reasons for the preference of a chemical precipitation plan, and to combat the popular idea that sewage products may be disposed of at a profit. To this latter end he quotes voluminously from the testimony given before the Royal Commission on Metropolitan Sewage Discharge in 1884; the bulk of which evidence is decidedly unfavorable to the realization of expected profits. In regard to the nuisance anticipated from the location of precipitation works at Fields Point, Mr. Gray gives a letter from Mr. J. C. Melliss, an engineer of high repute in England, in which letter Mr. M. details his experience of some fourteen years in this direction and gives much testimony tending to prove that with properly designed and managed works there is little or no smell outside of the works themselves, and that their presence would never be evident to people residing a distance of 2,000 feet from the station. A topographical plan and description of the Coventry, England, sewage works is presented to show their proximity to first class residential property.

The estimated cost of the entire precipitation plan, as proposed by Mr. Gray upon the same general basis as the before mentioned

schemes, is $3,699,504. The estimated cost of the parts of the work necessary for chemical precipitation, and which would represent the outlay or loss if at any time a different plan should be adopted is as follows:

Tanks	$81,500.00
Connections, Floats, etc	14 000.00
Filter Press and Engines	30,000.00
Buildings, Store house, etc	20,000.00
Total	$145,300.00

The plans and grades show that the proposed intercepting sewers will dispose of all the manufacturing waste from the numerous mills of Providence.

In preparing his estimates Mr. Gray has based his plans upon a population of 300,000 people; but as some think this too great a number he submits, in the present report, an estimate for sewers to provide for a population of 200.000 with the result that the saving over sewers for 300,000 inhabitants would only be $33,495.

As described in the appendix to the City Engineer's report of 1884, chemical precipitation on the plan proposed, is briefly as follows: The addition to the sewage of certain chemicals which promote the deposition of solids and a portion of the dissolved matters, in sewage. This mixture flows into precipitating tanks, where it comes to absolute rest and deposits the so called sludge, while the effluent or clear portion flows off after the chemical action has taken place.

The disposal of this sludge, of which about 90 per cent. is water, is the difficulty inherent to the precipitation process. The method proposed for Providence is the use of the filter press of Messrs. S. H. Johnson & Co., of Stratford, England, in which the sludge is compressed between "cloths" of stout canvas, and delivered in the shape of cakes nearly devoid of odor and sufficiently solid to be handled; the cakes still containing, however, about 50 per cent. of water. This compressed sludge may be used for manure, but its fertilizing value depends upon the nature of the sewage and the chemicals used; it may also be used for reclaiming land or other purposes.

Mr. Gray favors the Coventry process of precipitation, in which the chemicals are crude sulphate of alumina, proto-sulphate of iron, and lime. His personal inspection convinced him that the effluent from the Coventry tanks was quite colorless, with little or no odor, and showing a high degree of purity on chemical analysis. Dr. Voelcker, in the Local Government Report of 1876, estimated the practical market value of the Coventry sludge, as compared with farmyard manure, at 5s. 6d. to 8s. 4d. per ton; where the product still further reduced by drying the value would be greater; and Dr. Wallace, in the Glasgow Sewage Report of 1879, estimates that with ten per cent. of moisture only, it would be worth £1 7s. 2d. per ton.

The chief points made by Mr. Gray in recommending the chemical precipitation method is that it can be brought into action more speedily than any other plan; that the cost of the plant is comparatively small, and that precipitation can be combined with irrigation, and so reduce the area of valuable land required, should it be at some time deemed advisible to adopt the latter system in some form. Referring to Dr. Tidy's remark that "sewage is a great ugly thing that one has to spend money on to prevent it being a trouble and a nuisance," and Baldwin Latham's statement that "it must be looked upon as a dead loss in whatever way you have to deal with it," and that "the question is how to get rid of it most cheaply," Mr. Gray gives as his conviction that by precipitation the city of Providence can get rid of its sewage at the least expense and without causing a nuisance.

Our New Eight-Inch Gun.

We learn from the *Army and Navy Journal* that the new 8-inch gun built for the Army at the West Point Foundry, with a Whitworth tube and the Midvale Steel Company's hoops and breech mechanism has, after being fired thirteen times, opened a joint between rings that measures 0.004 of an inch.

Built up guns do not seem successful on the whole. The list of such guns found defective is a long one; among them are the two 100-ton Armstrong guns, the slipping of tubes at Alexandria, the loss of one-quarter the length of the 43-ton gun, on the Collingwood and the St. Chamond 16-inch gun that fired off the length of its calibre, with the withdrawal of the two Krupp 16-inch guns, for Spizzen, after the sixty-sixth and forty-first fires, to say nothing of the rumored bursting of his guns at Constantinople, making a chapter of failures that compares poorly with the record of our Rodman guns—only one bursting during the war; and now they have fired the one hundred and thirty-seventh successful shot from a cast-iron 54-ton gun at the Sandy Hook proving ground.

The plan advocated by Captain Michaelis, Mr. Metcalf, and others, of making cast-steel guns on the Rodman plan might not result in a better gun than those failing with such frequency in Europe, but it seems to be well worth trying, particularly as the "Board on Fortifications and other Defences" say they have estimated it would require at least three years to establish proper plant for the construction of modern (built up) guns, and two years more to get out and prove the first 16-inch gun.

Captain Michaelis, speaking of the sad effects resulting from our long desuetude of manufacturing ordnance, says the resulting mental phase has gone so far that we are in danger of becoming servile, shrinking from adopting American ideas until they have been approved by foreigners. Eugene Schuyler speaks of the Uriah Heap mental habit of certain Americans; how far this mental tendency actuated the Board above referred to in proposing nothing larger or better than they have in Europe, we leave our readers to judge.

Atlantic Express Steamers.

The *Engineer* of Aug. 13, in discussing the papers read before the recent meeting of the Institute of Naval Architects in England, makes some very practical remarks concerning the efforts now made to increase the speed of ocean steamers. We condense as follows:

After acknowledging the vast progress made in speed in a few years, as shown in such ships as the Etruria and Umbria, the enormous cost at which this increased speed has been obtained raises a serious question of practical utility. For example, the Brittanic of the White Star line, built more than ten years ago, consumes about ninety tons of coal per day of twenty-four hours and makes the average voyage in eight days nine hours to America, and eight days two hours to Liverpool; the total coal consumption is thus 840 tons per voyage. The Etruria, on the other hand, makes the average trip in six days twelve hours, and burns 320 tons per day, or 2,250 tons per voyage. So in saving thirty-six hours in time the latter ship burns 1,400 tons more of coal, which she must provide space for in addition to the greater engine space required.

The Servia is then compared with the Etruria; the time of the first being put at seven days and the best speed of the latter at six and one quarter days. According to the figures of Mr. John, of the Barrow Shipbuilding Co., the Servia burns 1,435 tons and the Etruria 1,969 tons on her short trip; or 500 tons of coal are expended for shortening the voyage eighteen hours. The Servia too is the larger ship, being 10,960 tons as against 9,860 tons for the Eturia; but the indicated horse-power of the Etruria is 14,321 as compared with 10,300 for the other. Here again, to save eighteen hours of time, we have 500 tons of extra coal, and a displacement of 1,100 tons less than in the slower boat, a space which could be utilized for freight. As the *Engineer* says the price paid for reducing the time of transit between Liverpool and New York seems to be out of all proportion to the result gained.

In describing the visit of the members of the Institute to the Etruria and its engines, the *Engineer* first calls attention to the huge dimensions, multitude of parts and bewildering intricacy of these machines, and says that "no amount of college training, no amount of mathematical education could have evolved such as these. This kind of training can only teach principles and the success of such engines as those of the Etruria and ships like her, depends from beginning to end on detail, and a consummate knowledge of detail can only be acquired by prolonged experience."

But, after saying further, that "it is this consummate knowledge of detail which places British marine engineers in advance of the marine engineers of every other nation under the sun," the *Engineer* proceeds to point out the fact that there is too much detail in the engines of the Etruria; the details are "overwhelming," in fact, and the editor does not believe that they are "necessary or desirable in the propulsion of a ship."

As the machinery of the Etruria is supposed to represent the acme of British marine skill, this is rather an unkind commentary on the British marine engineer. It is barely possible that his knowledge of detail is entirely too "consummate"; and that he at times sacrifices stern utility and the best, because the simplest and shortest method of solving a difficult problem, simply to show the marine engineers of "every other nation under the sun" how complicated an Englishman can make a machine that has a plain every-day duty to perform. From the showing of the *Engineer*, the engines of the Etruria lack a certain proportion of what American mechanical engineers call "common sense," or the strict adaption of all parts of a machine, in material, strength and detail of parts, to the work to be done; only that and nothing more.

PERSONAL

JOHN KERSHAW, formerly draughtsman of Jackson & Sharp Company, Wilmington, has gone to New York as inspector of the floats building for the Baltimore & Ohio Railroad Company.

Bridgebuilder OSCAR HILT, of Greenbush, N. Y., has returned from Lockport, where he has just completed an iron bridge. The Second avenue bridge in Lockport will be commenced in a short time.

COL. JOHN Y. CUYLER, for seventeen years Chief Engineer and Superintendent of the Brooklyn Park Department, resigned his office on September 7th. The reason given in his letter of withd wel was impaired health.

WILLIAM WHITNEY, who was recently with the Reading Railroad, has been given entire charge of the survey and construction of the new road that is to be built by the Lehigh Coal and Navigation Company in Luzerne county.

COL. JAMES C. DUANE, of the U. S. Engineers, will undoubtedly succeed Gen. John Newton, retired, as Chief of Engineers, U. S. A. Col. Chas. S. Stewart, the senior of COL. DUANE, will be retired at his own request on the 16th of the present month. COL. DUANE has an excellent record as an engineer, and has been long at the head of the Light-house Board.

MR. JOHN O'REILLY, a well-known civil engineer of Manchester, N. H., died on Saturday the 4th, at sixty-three. He was a graduate of the Dublin University, and practised his profession in Ireland and England before coming to this country.

WILLIAM JERVIS, for ten years Manager of the old Mississippi, Milwaukee and Wisconsin R. R., predecessor of the Chicago, Milwaukee and St. Paul R. R., died in Milwaukee on the 7th, at the age of seventy-three years. He was a brother of the late JNO. B. JERVIS, the Engineer of the Croton Aqueduct.

MR. R. L. TRAYLOR has been elected Treasurer of the Virginia Construction Company, vice W. C. Watts, resigned. Mr. T. T. Talley has been appointed Auditor, vice J. W. Daniels, resigned. Headquarters Cotton Exchange Building, Memphis, Tenn.

FREDERICK H. LEWIS, C. E., 413 Walnut street, Philadelphia, has been appointed Resident Engineer, and Inspector in the East for the Pittsburg Testing Laboratory.

GENERAL POLIGNAC, who served in the western Tennessee army, is worth not far from a million. He is the French soldier who came to this country at the outbreak of the war and offered his sword to the confederate cause. Though he did not gain any special distinction in the field he fought bravely till 1865. Finding that soldiering did not pay, he thereafter devoted his attention to civil engineering and soon attained distinction in the profession.

SIR WM. DAWSON, Principal of McGill College, Montreal, delivered the Presidential address before the British Association at Birmingham on the 2nd dealing mainly with the subject of the geological formation of the bed of the Atlantic and the climatic influences of the distribution of water on the surface of the globe. He favored the theory that the kernel of the earth is solid, but that there is liquid between the kernel and the surface. The crust of the earth, he said, is thicker and stronger than ever, affording a guarantee of its permanence, and the history of the ocean and the continent is an example of the progressive design equally with the history of living beings. The address was listened to attentively by two thousand persons and was highly praised.

[Later news states that Sir William Dawson considers that the developments of the recent earthquake which ruined Charleston, S. C., will cause him to alter the above theory of the interior of the earth.]

As the engineer of engine 1,277, on the Wabash, pulled out of Given, enroute for Ottumwa one evening recently, he noticed what appeared to be a small animal hopping along the track ahead of the pilot. Gradually he increased the speed of the locomotive, but the little quadruped seemed also to have "dropped another notch," and despite the tremendous gait of '77 easily retained its posititon. Disgusted beyond expression the engineer began heaving chunks of coal at it, but all in vain. It seemed to bear a charmed life and successfully baffled all endeavors of the engineer and fireman to check its wild career. For twenty-one miles the engineer had chased that delusive object, and thoroughly disgusted he gave up the race at Ottumwa and stopped. The object stopped also. With his pick in hand the engineer made a sneak on the animal, harmless but possessed of such anomalous migratory powers. With quick precision he brought the pick down full in the animal's back, but a "sickening thud" was the only sound he heard, and with a wild laugh he arose, henceforth to be a raving maniac. For a full hour he had been making desperate efforts to run over the shadow of a leaf adhering to the headlight, and the discovery and reaction was too much for his already shattered nerves.—*Burlington Hawkeye.*

CORRESPONDENCE.

Magnetic Variation.

UPPER STRASBURG, FRANKLIN CO., PA.,
August 31, 1886.

EDITOR ENGINEERING NEWS:

In reply to the inquiry of your correspondent from Mount Carbon, W. Va., I would put the declination at Charleston, some twenty or thirty miles west of the locality he names, for 1797, say about 2.055°, or 2°. 3′ east; and for 1857, about thirty-five minutes east. At his place it would have been a trifle less than the amounts above deduced, say about two degrees, or a little less in 1797, and about half a degree in 1857. But I would here observe that in a region where no records of observations at so early a date exist, except at considerable distances from the locality, it is next to impossible to determine closely the amount of variation so far back as 1797, but the variation since 1857 should not be so difficult to determine. In arriving at the above conclusions, I compared the declination of Charleston, W. Va., with Marietta, Ohio, Cincinnati, Ohio, Upper Strasburg, Pa., and with New Berne, N. C. Marietta is distant about 70 miles; Cincinnati, about 160; Upper Strasburg, about 180; and New Berne, about 325 miles. In Appendix 12, of Coast and Geodetic Survey Report page 258, we find the analytical expression of the values of the declination to be for

Marietta.

$$D = +.02^\circ + 2.89 \sin (1.4\ \text{m.} - 40.5^\circ)$$

Cincinnati.

$$D = -2.40^\circ + 2.02 \sin (1.42\ \text{m.} - 39.8^\circ)$$
$$D = +2.43^\circ + 2.90 \sin (1.55\ \text{m.} - 21.7^\circ) + .12 \sin (5\text{m.} + 140^\circ)$$
$$D = +0.806^\circ + 3.004 \sin (1.25\ \text{m.} - 21.4^\circ)$$

I have computed for Upper Strasburg, and also for New Berne, N. C.

Epoch, 1850; m = the years counted from 1850. The numerical values are as follows:

	Marietta.	*Cincinnati.*	
1797	−2.606°	−4.746°	
1857	−1.455	−3.696	
1885	+.480	−1.950	
	Upper Strasburg.	*New Berne.*	*Charleston.*
1796	−0.46°	−2.197°	
1797	−0.48	−2.196	
1857	+1.90	+.148	
1885	+3.892	+1.948	+1.30°

The rate of change for Charleston was obtained by giving each locality (of the four above named) its proportional weight invérsely as its distance from Charleston. If your correspondent is experienced with the nature of the declination of the needle, with its vagaries and uncertainties, I would advise him not to place too much reliance upon the figures given above, especially for the earlier date, as it is never safe to go much outside of actual observations. Then the diurnal variation, the electrical disturbances, and other troubles often upset the most finely spun theories. The old instruments were not always the best; surveyors often incompetent and careless. On the other hand, if he is an experienced practitioner and has wrestled with the perplexities of old surveys, I need not tell him what to expect, or what to do, in order to retrace correctly an old line, incorrectly run at first—except to keep cool, and not to mind the rattlesnakes, copperheads, blowing vipers, gallinippers, mosquitoes, gnats, and the very accommodating fellows who think he must be wrong, and offer any amount of advice gratis, when he is determining how to set his instrument to hit the old stake, long ago rolled away—if he can. This is Pennsylvania surveying; *perhaps* it may do in West Virginia.

JOHN B. KAUFMAN.

Retaining Walls for Earth.

EDGE MOOR, DELAWARE.
August 9, 1886.

Will you have the kindness to permit me to correct a few statements, made by ENGINEERING NEWS July 3, 1886, in relation to my book on "Retaining Walls for Earth?"

I did not state that Prof. Weyrauch's theory is not applicable to walls leaning backward; on the contrary I show how it is easily applied by combining it with Rankine's method which simplifies the problem. Weyrauch's theory in itself can be applied by considering the effect of the weight of the wall supported by the earth.

If the theory is true for any plane section in unlimited earth, as conceded in your notice, why is it not true for *any plane* whether it be of earth, sand, glass or stone?

Does not the mere fact of passing a plane through the earth, even if imaginary, separate one portion from the other, and can there be any relation between the two portions as long as the plane is considered to exist, and hence how can the material on one side affect the intensity or direction of the thrust of the other?

"Owing to its doubtful nature, and the great complexity of the formulas * * *"

The theory is founded upon one assumption, and only one, viz., all forces acting upon any imaginary plane section are parallel. The *intensity* and *direction* of the earth's thrust against the wall are deduced with mathematical accuracy as is also its point of application. To show how simple the formulæ are, the following not very simple, example is given.

EXAMPLE:—The side of a deep sand cut is to be retained by a surcharged wall built of rough blocks of limestone. The surface of the sand being at the angle of repose and making the angle $e = \varphi = 33^\circ\ 40'$, with the horizontal. The height of the wall $H = 20$ feet and its rear face making with the vertical the angle $\alpha = 8^\circ$ (wall not leaning backward.) Required the intensity and direction of the earth's thrust E.

ANALYTICAL SOLUTION

Let W = Wt. cubic feet of limestone..... 170 lbs.
" Y = " " " " sand..... 100 "

Equation (32)

$$w = 90^\circ - \varphi = 56^\circ\ 20'$$

Equation (34a)

$$\tan.(\alpha + \delta) = \frac{\sin.\alpha \sin.\varphi \cos.(\varphi - \alpha)}{\cos.\varphi \cos.(\varphi - \alpha)}$$
$$= \frac{0.13917 + 0.55436 \times 0.90133}{0.83228 \times 0.90133} = 0.8517$$
$$\therefore \alpha + \delta = 40^\circ\ 25' \text{ and } \delta = 32^\circ\ 25'$$

Equation (20)

$$E = \left[\frac{\cos.(\varphi - \alpha)}{\cos.\alpha}\right]^2 \frac{H^2 y}{2 \cos(\alpha + \delta)}$$
$$= \frac{0.90133 \times \frac{3}{20} \times 100}{0.99027 \times 2 \times 0.76135} = E = 23600\ \text{pounds.}$$

In the above simple manner the problem is quickly solved. $E = 23{,}600$ pounds, makes with the horizontal an angle $\alpha + \delta = 40^\circ\ 25'$ and is applied at a point below the top of the wall equal to two-thirds the height, all measurements made on rear face of wall. The wall is easily proportioned now by assuming same width on top. Assuming 2 feet, the base is found to be 9 feet and the resultant R, of E and G cuts the base 3 feet from the toe of the wall. The friction on the rear face of the wall has not been considered; if that is introduced as on pages 58 and 59 of my book, the wall would be materially lightened.

Thus it is seen that the formulæ are exceedingly simple in their application. The formulæ necessary to determine E and δ for plane earth surface inclined at any angle and wall making any angle with vertical can be placed on a single page of a note book, and applied whenever necessary.

GRAPHICAL SOLUTION:—The graphical solution of the above problem is much simpler even than the analytical.

Yours very truly,
MALVERD A. HOWE.

Charleston, W. Va., Water-Works.

Charleston, Kanawha county, West Virginia, is built on slightly undulating ground, in the valley of the Great Kanawha river, and immediately above the confluence of Elk river. Charleston is the capital city of the State of West Virginia and contains a population at the present time of about 7,000 people.

Water-works were commenced December 28, 1885, and completed August 30, 1886. Works were built by the Charleston Water-Works Company, after plans and specifications made by E. R. Davenport, who was also the general superintendent of construction.

Water is taken from Elk river through an inlet pipe to suction basin, and is from these pumped by two powerful compound, duplex pumps of the Deane Steam Pump Company make and pumped direct through two Hyatt filters into the city. Pumps are capable of furnishing 1,500,000 gallons each per diem, and the pipe system and machinery are capable of withstanding 200 pounds pressure per square inch. The two boilers are Ward's patent steam generators, of the water tube type, steam pressure has been put upon them, since they were put into the boiler-room, of 300 pounds per square inch. Pumps have steam cylinders 14 and 20-inch diameter, water plungers, 12 inches diameter, 18 inches stroke. Mason patent regulator attached to each pump.

Elk river is a mountain stream and the water is pure, except in case of freshets and during such periods the Hyatt filters are brought into requisition to reduce the turbidity.

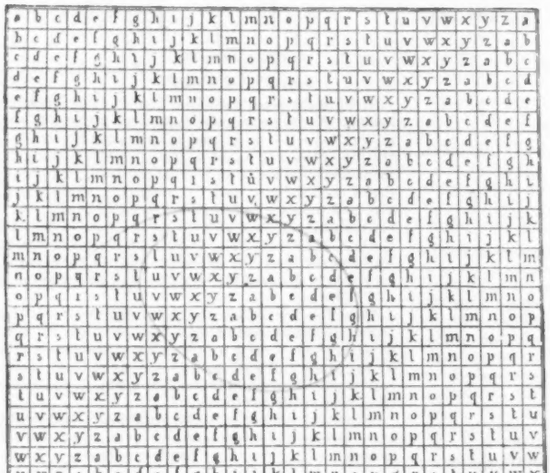
Distribution is by ten miles of Kalamein pipe from 16 inches down to 4 inches, with Ludlow valves and Ludlow hydrants. City pays $50 each per annum for hydrants, rentals and franchise runs for thirty years. Service pipes are also of Kalamein pipes.

Works were tested August 30, 1886, and bursted four of the fire department hose nozzles out of eight, with pressure from 130 pounds to 180 pounds. Fire pressure will be 100 pounds and domestic pressure forty pounds per square inch. J. H. Brown is President, and W. S. Laidley is Secretary.

Cryptography; Beaufort System.

From an interesting series of articles on Cryptography, in *Le Génie Civil*, we extract the following for the benefit of the curious in such matters:

This cryptogram is a modification of the "square table," and was suggested in 1857 by Admiral Francis Beaufort, R. N.; it was long regarded as indecipherable.



The Beaufort System.

The table was arranged as above; and to use it a literal key is selected which must be repeated as many times as necessary under the sentence to be written in cipher. For example, with the key *Oran* write in cipher the command—*Burn the city*. This will then be disposed as follows:

Burnthecity
OranOranOra

In the above a letter of the key is immediately under each letter of the original sentence.

Now to write the cipher:—Find *b* in the first horizontal alphabetical row and descend the vertical column until you meet *o*, the first letter of the key; then turn to the right or left and on the extreme end of the same horizontal column you will find *n*, which is the first letter of the cipher. By doing the same for each letter of the original sentence, we will obtain the following cryptogram:

B	*u*	*r*	*n*	*t*	*h*	*e*	*c*	*i*	*t*	*y*
O	*r*	*a*	*n*	*O*	*r*	*a*	*n*	*O*	*r*	*a*
n	*x*	*j*	*a*	*v*	*k*	*w*	*l*	*g*	*y*	*c*

or *nxjavkwlgyc*

To translate this cipher, it is only necessary to reverse the above process by writing over it the same key *oran*, and then finding *n* or *x* on the first vertical column, follow the horizontal column until you strike the *o* or *r*, and then on the first horizontal column will be found the letters forming the original sentence. In this cryptogram almost any language can be used if the words are written out in Latin characters.

THE VOLKER & FELTHAUSEN MANUFACTUSING CO., Buffalo, N. Y. have just shipped a large pump to the Water Works at Blue Island, Ill. This firm reports large increase in their pump business this year.

Newark, N. J., Intercepting Sewer.

The Common Council Committee on Sewers met last evening and transacted considerable business, the most important being in regard to the intercepting sewer.

John S. Shaeffer, Engineer and Superintendent of the Intercepting Sewer, reported as follows about the sewer: "The work, so far as can be ascertained at the present time, is in good condition, knowing that the utmost vigilance has been exercised during the construction.

"I was not aware of any unnecessary delay in the prosecution of the work; on the other hand, the contractors have pushed the work rapidly, notwithstanding their contract gives them until Jan. 1, 1887, to complete the same. As to additional cost, I can say that the cost of the system when finished, in excess of preliminary estimates, will be due to quicksand and other bad material encountered almost the entire length of the excavations, also to a large expenditure for pumping plant not anticipated in said preliminary estimate. In carrying out the work the detail plans, so far as finished, have been made solely with a view to a successful completion and operation of the system. The sewer and outlet flume, about five miles in length, are completed. There remains to be finished the sewer of deposit, pumping plant, discharge well, filth hoist, including buildings and connections with intercepted sluices, and structure at discharge end of flume in the bay."

Following is a detailed statement of work and additional expenditure necessary to complete the system under existing contracts:

Seven thousand three hundred and seventy-five lineal feet of excavation in trench above grade and refilling $22,061.25; 15,918 lineal feet of excavation in trench above grade and refilling, $39,635.83; 51,151 cubic yards of excavation not in trench above grade and refilling, $45,720.80; 581 cubic yards not in trench below grade, $517.09; 23,624 cubic yards of excavation for foundation for pump-house and fixtures, $16,536.80; 3,553,565 feet of hemlock timber for foundation, $81,731.99; 319,540 feet of spruce timber for sheathing, $6,390.80; 2,124 lineal feet of oak or white pine piles, $1,253.16; 6,114 lineal feet of spruce piles, $2,384.46; 6 cubic yards dimension stone masonry, $84; 8,293 cubic yards of rubble stone masonry, $66,344; 18 cubic yards brick laid in cement mortar, $171; 6,989 cubic yards of brick laid in Portland cement mortar, $85,615.25; 2,964 cubic yards of concrete, $20,748; 30 lineal feet of 8-inch drain pipe, $15; 11,860 lineal feet of 12-inch drain pipe, $10,079; 66,079 pounds of wrought-iron, $3,303.70; 83,350 pounds of cast-iron, $3,334; 100,000 feet of hemlock timber, $1,500; 1,121 cubic yards rip-rap stone, $3,082.75; total to date, $410,498.87. To material and work on pumping engines and boilers to Watts, Campbell & Co., $45,400; total, $455,898.87. The amount due on contracts of Watts, Campbell & Co. is $17,700. The work not estimated and to be done to complete the contract will be about $44,500, making the probable cost when completed $518,098.87.

Alderman Connelly said this was too important a matter to let it rest on the mere reading of a report. This report shows an immense increase in the cost of the work over what had been anticipated, and yet the work is far from being completed. The Street Commissioner and the City Surveyor have had no direct supervision of this sewer, as they have of all other sewers, and in order that this committee may get at the correctness of this report, he would move it be referred to the City Surveyor and that he report in detail as to its correctness. This was carried.—*Newark Advertiser.*

WATER.

HOLDEN, Mo.—Water works are being discussed. Direct Pressure. Stand Pipe and Reservoir: cost $40,000. 4½ miles pipe; 50 hydrants. City proposes to own the works. To be voted on as soon as possible, a few weeks hence. Geo. W. Pearsons, of Kansas City, is preparing the plans and specifications.

LINCOLN, NEB.—Already more water is a subject for discussion. The wells sunk were to provide for 20,000 people, the population is now 30,000, and "still they come." The present well will furnish all the drinking water necessary but it will not long hold out for irrigation, manufacturing and elevator purposes.

THERE is more building going on in Chicago now than at any time this year. The season is at its height; and labor of all kinds is in marked demand. Business in all branches is excellent: and merchants are crowded with orders. Collections are very good with exceptions.

THE SPRING AND BROOK WATER. Situated in Pleasant Valley, Lucerne County, Pa., has been organized. C. E. Chittenden, Pres. Capital, $100,000. Object to supply the towns of Lackawana, Moosic and Pleasant Valley with water, they have made a contract with the Dickson Works of Scranton, to furnish them with pumping engine, Mattes pattern, capacity 1,000 gallons per day. They have also made a contract with C. R. Kinsley, of Scranton to build the water works. Every thing to be completed in six weeks. All stock is subscribed for and 15 per cent. paid in.

NEWS OF THE WEEK.

CONTRACTING.

Court House.—Bids are advertised till October 10th, for Pulaski County, Ark., Court House, by County Judge Hill. Building will be of brick and stone, fireproof throughout. Estimated cost $50,000. Max. Orlopp, Little Rock, Ark., architect.

Sewerage of Danbury, Conn.—John B. Healy, of New York City, has been awarded the contracts for sewers of Danbury, Conn., and has a large force now at work.

Cincinnati has thus far spent for street improvement, under the $4,000,000 bill, $1,888,939.69 for granite and $8171,731.61 for asphalt. Total, $2,070,670.76.

Water Works.—Thomas Bros. have the contract for building the water works reservoir at Turners Falls, Mass. It is to be on the north end of the hill and 10,000 yards of excavation will be made. Bids for supplying the machinery will be opened to-morrow.

University.—O. Caldwell, the builder, Mobile, has the contract for the construction of the Garland Hall of the State University at Tuskaloosa. It is to be three stories high and 120x130 feet, and is to cost $25,000.

Contract Work Postponed.—Proposals for furnishing stone, etc., for the harbor of refuse at Lake City, Minn., as per official advertisements, have been returned by Maj. Mackenzie, with the statement that the commencement of work would be postponed.

Abstract of Proposals.—For dredging harbor at Baltimore, opened at 1 P.M., September 7, 1886; P. Sandford Ross, Jersey City, N. J. $17⅞ Morris & Cummings Dredging Company, New York, N. Y., $17.⅞; Geo. C. Forbes & Co., Baltimore, Md., 18 cents; American Dredging Company, Philadelphia, Pa., $17⅛; National Dredging Company, Wilmington, Del. $18½; Baltimore Dredging Company, Baltimore, Md., $17.⅞. All rejected, too high, work is readvertised, the proposals to be opened Sept. 16.

For removing wreck of schooner "B. Oliphant," in Chesepeake bay, opened at noon of Sept. 7, 1886: Wm. M. French, Berkley, Va., $800; L. E. Broom, Baltimore, Md., $945; Lewis & Talbott, Baltimore, Md., $800; American Dredging Company, Philadelphia, Pa., $900.

Railroads, Bridges and Canals.

Change of Gauge.—CAIRO, ILL., August 31.—The gauge of the St. Louis, Arkansas and Texas will be changed to standard, the work being completed October 15 or 16. Seventy engines, 1,500 cars and 250 trucks for old cars have been ordered, while new locomotives will begin arriving here in the morning.

The Poughkeepsie Bridge.—The Poughkeepsie *Eagle* is authority for saying that the piers yet to be built at that point will differ from the two now partially constructed. Piles will be driven and sawn off at the river bed and on these a timber crib will be sunk to support the steel towers. Work has not yet commenced.

Galveston Sea Wall.—Judge Ballinger, of Galveston, advocates a system of sea-walls for the better protection of that city, and estimates the cost at $200,000. Another, a Mr. T. C. Thompson, suggests a simple system of driven and braced piles, at a cost of $70,000; and in very vague but high sounding terms finds fault with the engineering of the U. S. Government.

Galveston, Sabine & St. Louis R. R.—Money has been procured for widening the gauge of this road, and engineers are making up the data for the letting of the work. This is the line recently bought by the Whitneys of New York.

The Electrical Subways

The Commissioners of Electric Subways for this city were appointed under authority of an Act passed June 15, 1885, providing for placing electrical conductors under ground in cities of this State, and for commissioners of electrical subways; enacting that in cities with a population between 500,000 and 1,000,000 the Mayor, and in cities of over 1,000,000 inhabitants the Mayor, Comptroller and Commissioner of Public Works, are authorized and directed to appoint three disinterested persons a Board of Commissioners, and the duty of such board is "to cause to be removed from the surface and put, maintained and operated under ground, whenever practicable, all electric wires or cables used, or to be used, in the business of any such company in any street," and so as to enable and require companies operating or intending to operate electrical conductors to transact their business with underground conductors when practicable.

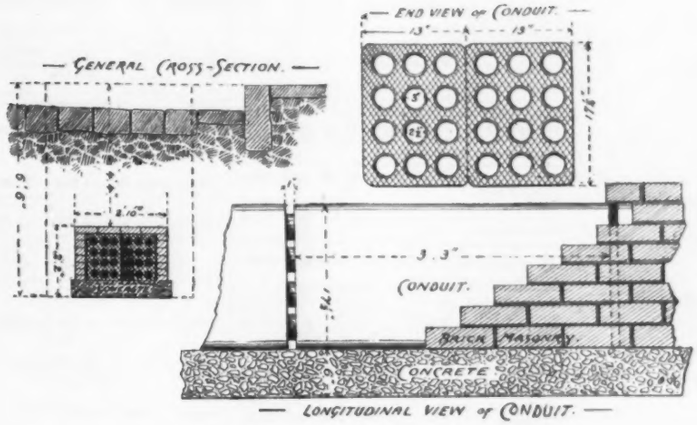
The bill further directs that the board should, if no suitable plan is proposed within sixty days, devise such general plan as will meet the requirements of the Act, and the board shall have full authority to compel all companies to use such subways.

The board as constituted subsequent to the death of Commissioner Loew, is organized as follows: Roswell P. Flower, President; Jacob Hess, Theodore Moss, Secretary, with Henry S. Kearney, Engineer.

Shortly after the reorganization of the board a contract was made with a company which has given a bond of $500,000 to furnish the necessary conduits, ready for occupancy, to the various telegraph and telephone companies. This contract, to which we will refer in a subsequent number, is peculiar in that it binds the contractors to build and maintain their conduits as the commission directs, without specifying either the size, material or style of the required work, and also prohibits their refusing accommodations to any company, or in any way discriminating against them, and provides that their compensation, to be derived from the lines using the conduits, shall not exceed the ascertained expense of maintaining the wires above ground.

About the time of negotiating this contract, experiments which till then, had apparently been confined to conduits in which the cementing material was coal tar pitch, were extended to cover the natural asphaltes and bitumens, and on August 19th a public test was made for crushing and transverse strength, under the direction of Dr. A. R. Ledoux, the chemist of the commission. Mr. F. Collingwood, C. E., who was present and worked out the results for the *Sanitary Engineer*, has kindly given us a copy of the results as below, with his deduction of the tensile strength. It will be noticed that there was no record of the expansion and contraction due to changes of temperature and the prisms, 6x6, 30 inches long, were not fitted for breaking by tensile strain, although two small specimens were broken in the cement testing machine. So unless other pieces are made for that purpose, the very important question as to whether the conduits will pull themselves apart from the expansion and contraction due to changes in temperature still remains open.

It should be further noted that many if not all the asphalte mastics were made more meager in bitumen than is usual, in consequence of a provision in the specifications that the material should stand a crushing strain of 4,000 pounds per square inch, or nearly three times that of brick-work, an impossibility for asphaltic mastics as ordinarily



General Plan of N. Y. Electrical Subways.

Test of Material for the Electric Subway in New York.

TESTS BY TRANSVERSE LOADING ON SUPPORTS TWO FEET APART.

Name of Manufacturer.	Mark on Sample.	Description.	Depth. Inches.	Width. Inches.	Total breaking weight applied at center. lbs.	Max. strain per sq. in. at exterior (by formula.) lbs.
Neuchatel Asphalte Co	No. 1	Prism of *rock asphalte* mastic, made of their ordinary mixture for floors, etc., of Val de Travers (Neuchatel) mastic, Trinidad bitumen, grit, and sand.	5.6	6.51	4,000	706
H.R. Bradbury, Agt.	No. 2	Prism made of Val de Travers *rock asphalte*, mastic, 270 lbs.; sand, 257 lbs.; Portland cement, 35 lbs.; refined Trinidad asphalte, 63 lbs. After turning into the pail the temperature was 387° Fah.	5.9	6.43	5,100	820
New York Mastic Co.	"A"	Prism of *rock asphalte*, mastic, made of Seyssel mastic, 55 per cent.; fine gravel, 35 per cent.; bitumen, 10 per cent.	5.94	6.26	4,800	782
E.H. Wootton	"D"	Prism of Seyssel mastic, 35 per cent.; fine gravel, 55 per cent; refined Trinidad bitumen, 5 per cent; Portland cement, 3 per cent.; sulphur, 2 per cent.	5.88	6.04	4,140	708
Dorsett Conduit Co	D1	Prism of *coal tar pitch* mastic, made of 80 parts sand, 20 parts coal tar pitch, and a little oil and manganese.	5.9	6	3,780	652
	D2	By analysis, 78 parts sand and gravel, 17.5 parts pitch, and 4.5 parts oil and manganese.	5.9	5.9	4,460	782
Barber Asphalt Co	1B	Prism of Butler's patent bituminous mixture, made of double refined Trinidad bitumen (épurée), 130 parts; paraffine, 5 parts; broken and powdered stone, mixed, 6 parts; silicious sand, 80 parts; wood fibre, 50 parts.	6.	6.	4,380	730
	2G	Trinidad asphalt, 30 parts; sand, 45 parts; broken stone, 45 parts.	5 91	6.	2,260	380
Bolze	1	Prism of Limmer *rock asphalte* mastic, composition not known.	6.	6.01	4,200	698
Herman Poole	1	Prism of "Ferroid," consisting principally of sulphur and sulphide of iron.	6.31	6.01	1,580	238
	2	Prism of "Ferroid," consisting principally of sulphur and sulphide of iron.	5.73	6.32	4,720	822
Jno. Thompson. (Eng. of Com.)	.....	Rock asphalte mastic, composition not known.	6.5	5.9	2,020	292
Barber Asphalt Co	G1	Section of conduit made from same mixture as 2G above, with four longitudinal holes, 2 inches in diameter.	6.8	6.8	1,850	250 approximately.
	G2	Section of conduit made from same mixture as 1B above, with four longitudinal holes, 2 inches in diameter.	6.8	6.9	4,960	650 approximately
Dorsett Asphalt Co.	D	Section of conduit made from same mixture as D1 above, with ten longitudinal holes, 2 inches in diameter.	7.9	15.8	12,280	500 approximately
Richardson	.....	Sectional of conduit made from hydraulic cement concrete, with ribs top and bottom, and two longitudinal holes, each 2¼ and 1⅝ inches diameter; supports, 20 inches apart.	9. thr'gh ribs.	7. diam.	3,299	.....

TENSILE TESTS.

						Per. sq. in. lbs.
Dorsett Asphalt Co.	D	Made of same mixture as D1 above.	.....	.....	.....	514
Continental Conduit Co	.....	Grant's patent mixture.	.....	.....	.....	497

CRUSHING TESTS.

NAME OF MANUFACTURER.	Mark of Sample	DESCRIPTION.	Depth, in.	Lateral dimensions, diameter, inches.	Area sq. in.	Total load at crushing, lbs.	Crushing test per sq. in. lbs
West India Asphalt Co.	.....	Cylinder of bituminous mastic concrete, made of 30 per cent. Pédernales bituminous (from about 100 miles from Trinidad), and 70 per cent. coarse sand.	1·415	2·095	3·742	11,320	3,025
Dorsett Asphalt Co.	No. 1	Cube of same composition as D1 in Transverse Tests.	2·065	2·045x2·135	4·366	18,500	4,235
	No. 2	Cube of same composition as D1 in Transverse Tests.	2·098	2·120x2·065	4·378	20,110	4,591
Neuchatel Asphalte Co.	No. 1	Cube of same mixture as No. 2 of Transverse Tests.	2·	2·035x2·025	4·121	4,900	1,190
	No. 2	Cube made of Val de Travers rock asphalte mastic, 270 lbs.; sand, 240 lbs.; Portland cement, 54 lbs.; Trinidad asphalte, refined 45 lbs. Temperature in the pail 380° Fah.	2·045	2·065x2·045	4·213	9,730	2,311
New York Mastic Co.	"A"	(Cube) same as "A" in Transverse Tests.	1·925	2·110x2·	4·220	3,700	877
	"B"	Cube from mixture of Seyssel rock asphalte mastic, 50 per cent.; fine gravel, 40 per cent.; bitumen, 5 per cent.; refined Trinidad bitumen, 5 per cent.	1·950	2· x2·145	4·290	20,710	4,828
	"C"	Cube from mixture of Seyssel mastic, 40 per cent.; fine gravel, 45 per cent.; refined Trinidad bitumen, 7 per cent.; Portland cement, 2 per cent.; sulphur, 1 per cent.	1··60	2·120x2·145	4·547	14,800	3,253
	"D"	Same as D in Transverse Tests.	1·900	2·145x2·	4·290	14,450	3,369
Barber Asphalt Co.	G1	Cube of the same mixture as 2G in Transverse Tests.	2·	1·950x1·985	3·871	3,560	920
	G2	Cube of the same mixture as 2G in Transverse Tests.	1·940	1·995x2·015	4·020	3,870	963
	B1	Cube of the same mixture as 1B in Transverse Tests.	1·995	3· x2·020	4·040	6,600	1,634
	B2						
	No. 1	Cube of the same mixture as 1B in Transverse Tests.	1·960	1·975x1·935	3·920	6,470	1,651
	No. 2	Cube of the same mixture as No. 1 Bolze in Transverse Tests.	2·975	3·060x3·025	9·256	7,290	787
Bolze	.....	Cube of the same mixture as No. 1 Bolze in Transverse Tests.	3·060	3·015x3·045	9·181	7,110	774
Herman Poole	.....	Cube of "Ferroid."	1·975	2·025x2·020	4·090	22,250	5,440
J. McIntyre	.....	Block "Carbone Concrete," made of coal ashes and tar, mixed and molded, and then burned in a furnace until all volatile matter is burned out.	2·515	9·316x8·750	34·256	104,800	3,058
Dorsett Asphalt Co.	.....	Part section of conduit as described before. Crushed on edge.	15·8	7·9 x19·	.....	59,210	.....

fabricated unless at extremely low temperatures.

As the experiments showed no deficiency in the strength of the material employed by the Dorsett company, and as they were equipped with a factory which is supplying their conduit to the Underground Commission in Brooklyn, it was decided to commence laying their conduits on Sixth avenue, between Twenty-third and Fifty-ninth streets. It is asserted that experiments are being continued, and if the difficulty of withdrawing the mandrills that must be used to form the holes for the wires can be overcome, either rock asphalte or a preparation by the Barber paving company will be used in one or more instances, as continuous conduits can be made with either of these substances.

The decision to adopt the Dorsett conduit of coal tar pitch, brought out a rather pungent letter to Dr. Ledoux, the chemist of the commission, from W. O. Callender, who has for a long time been connected with either the Neuchatel or Seyssel Asphalte companies, in which, after quoting the decision of the commission to use "An Asphalt or Bituminous concrete," he says, "Natural Asphalte or Bitumine have been used from time immemorial for all kinds of engineering works, and in every case, where the work has been executed by men who understood their business, with unfailing success."

He then refers to the well-known and universal failures of all coal tar pavements as well as when used in covered ways, brewery floors, etc., in this country, and stating that in Europe engineers had been led by the superior cheapness of coal tar combined with the theoretical certificates of chemists, based on analysis, to employ coal tar for water proofing bridges and tunnels, as well as for damp courses in buildings, and it had, after a greater or less time, invariably failed, containing within itself, according to Dr. Dupre, "a celebrated chemist," elements of decay and disintegration, citing particularly the case of the St. John's Wood branch of the London Metropolitan Railway, when, "on the construction of the first part of the line this mixture (coal tar) was used, while on the second, a preparation of natural asphalte was employed with the result that while in the former cases there is no part but is saturated with water in the latter it is perfectly dry."

"Yet with all these facts, which are now known to most chemists who have studied the subject, it is announced, time after time in the newspapers, that a company who use nothing but coal tar pitch are now making the conduits."

"To me it seems to be, to say the least of it, a very risky experiment to use this material upon such incomplete and unsatisfactory trials as those made; it being the experience of every well-known chemist throughout the world that a gradual and certain deterioration is absolutely certain. In no case in all my experiences, both in the Old World and in the New, has any durable work ever been done with coal tar, and I may safely say, that in no case where honest and careful work has been done with genuine natural asphalte, has it ever failed." "It is known that genuine asphalte is an insulator of the first class, and that both gutta-percha and rubber are not in the least affected by it, but from experiments made I find that these materials are completely destroyed if they are embedded in coal tar pitch."

After quoting J. W. Chisholm, President of the Thomson-Houston Illuminating Co., of Chicago. "The material is of a nature permeable by gases and afterwards by water. Hydro-carbon gases from the leakage of the gas pipes permeate it and make it porous. They claim it is an insulating material, but after a short time it is not. It is at all times saturated with moisture, and is as good a conductor as earth," he concludes: "I *know* that it is impossible to make any permanent works out of coal tar or its products, and I do not want a repetition of my former experiences and a loud condemnation of asphaltic conduits, when in fact no asphalt whatever had been used in their construction."

While there is no doubt that coal tar products are not to be trusted in many situations, we would like to hear from our coal tar roofers as to some of Mr. Callender's assertions and would state that in the Dorsett preparation sesqui-oxide of Manganese is added, making an extremely hard, almost metallic, substance at ordinary temperatures, as the above tests show, and it is possible that, as the Dorsett people claim, they have a very different substance from the ordinary coal tar products. It may prove porous and not able to stand the action of illuminating gas, but it does not appear to have any loose oil about it that can be given off by the action of the atmosphere.

The mastic of which the Dorsett conduits are made is composed mainly, as shown above, of coal tar, pitch and sand. The heated sand is thrown into a circular pan in which the melted pitch is kept hot by a steam jacket, and the two are thoroughly mixed by a revolving stirrer, the Manganese being added at this time. The conduits, which are in about three foot lengths, are molded about a group of slightly tapered steel mandrills, which are encased in a movable iron case divided lengthwise into two parts. The mastic is brought in a shallow box, that fits the top of the mould, and when placed in position the sheet iron bottom is withdrawn depositing the charge uniformly between the mandrills, where it is tamped with a weight raised by a flat stem which passes between two wheels armed on about half their peripheries with india rubber belting; as the wheels revolve toward each other the belting grips the stem and raises it while the bare part of the wheels allow it to drop. When the mould is full water from a hose is played upon it, the mandrills are withdrawn from below by the aid of a screw, and the mould containing the conduit is swung by a derrick into a pit of water where it is allowed to cool. Notwithstanding the tamping, broken pieces show a rather porous texture.

The conduit laid on Sixth avenue is a 24-hole conduit and as no machinery was in readiness to handle blocks as large as are required it is made in two parts as shown in the figure. The ducts are 2½ inches in internal diameter with an enlargement to 3 inches at the ends, into which a straw board union, dipped in coal tar pitch, is inserted after the two ends have been heated by pressing them against a hot iron plate, to form continuous ducts. The unions are of such length that from one to two inches are left between the ends of the sections of conduits, and this space is filled with hot coal tar mastic which is carefully tamped.

As will be seen from the accompanying illustrations the conduit lies on a foundation, 6 inches in thickness, of concrete, and is guarded with a 4-inch brick wall and covered with bricks on the flat, all laid in hydraulic cement. While this may not produce a perfect electric conduit, it will be noticed that both in the mode of joining the sections and in casing the conduit it presents the most thorough and painstaking effort that has yet been made.

Many of the companies now occupying the streets are said to be strongly opposed to the plans and proceeding of the Commission, and considering that the provisions against discriminations will make it easier for new companies to gain access to the business part of the city, the assertion is not received with wonder.

The Iron Market.

The market has maintained a degree of activity that is very satisfactory. Everyone seems to be busy. There is no room for fault-finding on that score, but the meagerness of profits and the difficulty of getting an advance is a constant source of dissatisfaction. Changes during the week are almost too small to be discernible, but the asking rates are about a dollar per ton advance on angles and plates, and 25 to 50 cents on old rails and scrap iron. Pig iron, bar iron and steel rails just about hold their own, but are somewhat less active than they were a week or two ago.

The outlook is thought to be fully equal to what it has been for some time past, and, although large consumers, such as car and locomotive and bridge-builders, machinists and other important interests have large orders on their books, the capacity for production is so great that every demand seems to be easily met, for which reason the belief in higher prices does not prevail to the same extent as it did a little while back. Of course if there is any material increase in the demand prices will soon show it, but from present appearances there is no immediate probability of such an event. The pig iron market has been somewhat quiet, and although there is not a great deal of iron for sale, such as there is goes off slowly.

THE FUTURE COURSE.

It is almost impossible to form any very decided opinion as to the course of the market, except that the changes will be within very narrow limits. Prices cannot decline without causing an immediate shrinkage in production, neither can they advance without increasing both foreign and home competition. This feeling prevents anthing like speculation, so that the demand is regulated entirely by the current requirements of the consumers. What proportion this bears to consumption throughout the entire country cannot be estimated with exactness. In the East the supply appears to be slightly in excess. West and South reports indicate just the reverse. Taking an average of the entire country there is probably no great disproportion, demand and supply being very evenly balanced. Prices remain at about $18.50 to $19 at tide for No. 1 foundry; $16.20 to $17.25 for No 2 and $15.75 to $16.25 for gray forge, with somewhat higher figures on favorite brands, and occasional concessions on outside lots, or such as are pressed for immediate sale. No probability of change in the immediate future.

In manufactured iron the movement has not been specially important, but the market is firm and in some specialties, such as plates and angles, prices are probably a shade dearer. It is very difficult to establish any general advance, however, and with many it is a matter of theory rather than of actual realization. From the bottom figures of the year bars are nominally from 5c. to 10c. dearer, angles 10c. and plates 10c. to 15c, with another 5c. advance in prospect, providing the demand holds out. The demand for skelp iron has been most helpful to a great many mills.

FILLED THE VACANCIES.

It has filled in nearly all the vacant spaces for months past and given a great deal of employment, and altogether it may not have been at very remunerative figures, it has done much towards steadying the market. Prices remain at about 1.8 to 1.9 for best refined bars, 2 to 2.1 for plates and angles, and about 1.85 to 1.9 for skelp iron. Puddled bars are scarce, and under a good demand are 25c. to 50c. per ton dearer—say $28.25 to $28.75 at mill.

In steel rails there is no change; mills full of work and early requirements of buyers pretty well covered. For 1886 deliveries prices are firm at $35.50 to $35 at mill and for later dates $34 to $35.50.

Old rails are wanted at $21, spot, or $20.50@20.75, to arrive September and October. Good demand for interior deliveries at at prices varying from $22@23. No 1 scrap scarce and firm at $19@20, Philadelphia, or $21@ 22, deliveries.—Philadelphia *Press* 6th.

LABOR IN CHARLESTON, S. C.—Telegrams continue to pour in, offering aid and asking about work for mechanics. Five or ten thousand carpenters and bricklayers and ten thousand laborers could readily find employment here. The Knights of Labor he e arranged the following schedule of prices for labor, and members are not permitted to receive more; Bricklayers (first-class), from $3 to $3.50; second-class, from $2.50 to $3; carpenters (first-class), from $2.50 to $3; second-class, from $2 to 2.50; third class, from $1.50 to $2; painters, from $1.50, $2 and 2.50 to $2.50 and $3; plasterers, from $2 and 2.50 to 3; tinners, from $2 and $2.50 to $2.50 and $3; laborers, from $1 and $1.50 to $1.50 and $2.—*The State* 7th.

DR. DAVID HOSTETTER, of Pittsburg, became surety Andrew Hartupee, contractor for the new city water-works. Hartupee broke his contract and Hostetter settled a suit brought by the city for $143,500. Hostetter has paid the city $400,000 altogether.

CONTRACTORS INTELLIGENCE.

Engineering and Building Materials.

WHOLESALE PRICES.

Chicago, September 9, 1886.

IRON.

Quotations given by Jones & Laughlin.

STRUCTURAL IRON.			
Angles	2.30	@	2.40
"	2.40	@	2.50
Tees			.2¾c.
Beams, channels, American			.3½c.
Tank plates			2.40
Shell plates	3.00	@	.3¼c.
Steel plates, Tank			.3c.
Quotations by Fieldhouse, Butcher & Belden.			
WROUGHT-IRON PIPE.			
Butt welded, black.....Discount			.42½
" galvanized... "			.32½
Lap " black... "			.55
" " galvanized... "			.37½
Quotation by National Tube Co.			
Boiler Tubes			.50
Quotations by North Chicago Rolling Mills Co.			
RAILS.			
Steel	$37.00	@	$38.00
Old Rails—Iron	21.00	@	22.00
" —Steel	20.00	@	21.00
R. R. spikes			2.40
R. R. splice-plates	1.90	@	2.00
R. R. track bolts, square nuts			.3c.
Barb wire fencing, galvanized			.4c.
" " painted			.3¼
Quotations given by H. Green & Bros.			
CORRUGATED IRON-SHEET.			
Wire gauge.....16 to 20	22	24	26
Black, per lb	3¼	3⅛	3⅛ 3⅛
Galvanized per lb	8¼	9¼	9¼
Nos. 28		6.00	4
NAILS.			
Iron, per keg	2.10		
Steel, " "	2.20	@	2.25

METALS.

COPPER.			
Lake Superior			10.25
LEAD.			
Com. Domestic	4.75	@	4.80
Lead Pipe	.06¼c	@	.06¾
Tin-Lined Lead Pipe	.15		
Sheet Lead	.07¼		
ZINC.			
Sheet	5.65		

BRICK.

Quotations given by Lockwood & Kimball.

Common.....per M	8.00	@	8.50
PRESSED.			
Chicago, Anderson	18.00	@	27.00
Indiana	16.00	@	22.00
Perth Amboy, Buff			50.00
" Mottled			50.00
Tiffany	22.00	@	30.00
St. Louis			27.00
Trenton	40.00		
Philadelphia			45.00
Baltimore			55.00
Milwaukee			25 00
Zanesville			30.00
" Enamelled			50.00
Toledo Red, common			12.00
" stock			17 00
Fire Brick	25.00	@	30 00

LIME, ETC.

			Per Cask.
Chicago Lime	.65	@	.75
Wisconsin "	.90	@	1.00
Hair—cattle, per bu	.20	@	.25
" —goat, "			.40
Sand, Lake shore, per yd	1.00	@	1.25
Plaster of Paris	2.00	@	2.50

CEMENT.

Portland			3.50
Milwaukee, Utica, Louisville, Akron			1 25
Keene's Coarse	7.50	@	9.00
" Fine	11.00	@	12.00

STONE.

Quotations given by Chicago Stone Co.

			Per cubic foot.
LIMESTONE, Promiscuous blocks, f. o. b. cars; Chicago.			
Blue Bedford			.65
Buff			.56
Joliet	.35	@	.50
Lemont	.40	@	.50
FOUNDATION.			
Dimension, on dock	.16	@	.20
Rubble, per cord	.20	@	.25
Sidewalks, laid, 8" to 12" } sq. ft.			
" " 6" to 8" } sq. ft.	.65	@	.75
Planed	.40	@	1.00
SANDSTONE, Promiscuous blocks.			
Amherst	.50	@	.75
Berea	.55	@	.65
Philadelphia brown stone			1.50
Connecticut "			1.50
Carbondale			1.10
Malone Blue Euclid	.55	@	.65
New York Bluestone	.35	@	1.40

MARBLE.

Quotations given by Georgia Marble Co.

Cherokee, Georgia and Creole Marble			1.70
Ettowah			2.20
Rutland	3.00	@	9.00
Quotations given by Davidson & Sons.			
Concord			5.25
Sutherland Falls	2.50	@	5.50
St. Lawrence			5.00
East Dorset Italian	2.50	@	4.50
Mountain Park	2.25	@	6.00
Vermont			3.00
Tennessee, Red	7.00	@	9.00
" Concord	2.50	@	5.00
Italian, Veined			4.90

Quotations given by Georgia Marble Co.

SLATE.

Quotations given by Edward Johnson, 14 and 16 East Van Buren street.

Green Roofing, per square			5.20
Purple " " "			6.00
Red " " "			12.50
Black Lehigh " "	5.25	@	5.50
" Bangor " "	5.50	@	5.80

LUMBER, Car Lots.

			Per M.
THICK CLEARS AND SELECTS.			
Mixed Lengths, Dry.....Rough	20.00	@	47.00
ONE INCH FINISHING.			
Mixed Lengths, Dry.....Rough	24.00	@	47.00
12-INCH STOCK BOARDS.			
D to A	23.00	@	42.00
Common Stock Boards	11.50	@	16.00
BOX BOARDS, D to A	22.00	@	24.00
FLOORING STRIPS, ROUGH, 6-INCH.			
1st and 2nd clear			39.00
A Siding " Strips			39.00
C and A Flooring "	22.00	@	30.00
FLOORING DRESSED AND MATCHED.			
D to A, 6-inch	17.00	@	34.00
No. 1 Fencing	13.00	@	18.00
Norway, clear, C to A	17.00	@	22.00
8 and 10-inch No. 1 Boards, D and M	14.50	@	15.00
C to A Partition D and M, 2 sides, 4 beads	27.00	@	39.50
Beaded C and King, Tied	14.50	@	32.00
Common and Cull. Boards, Dry	11.00	@	13.00
Common and Cull. Fencing	11.50	@	13.50
BATTENS.			
O. Gt. or Beveled per 100 lin. ft.	.50	@	.70
TIMBER, JOISTS AND SCANTLING.			
All 2x4, 12 to 24 ft	$12.00	@	$13.50
" 2x6, " "	12.00	@	16 00
" 2x8, " "	12.00	@	14.50
" 2x10, " "	12.00	@	16.00
" 2x12, " "	12.00	@	17.00
4x4 to 8x8 " "	12.00	@	15.00
2 inch cull. plank, prom' width			9.00
2x4 " " 12, 14 and 16 ft			10.00
BOARDS, ordinary dimensions.			
Pine, 1st quality clear	$46.00	@	$48.00
" 2nd " "	44.00	@	47.00
" 3rd " "	42.00	@	44.00
Common			13.00
SIDING.			
Pine	10.00	@	21.00
FRAMING TIMBER, Pine	12.00	@	17.00
Laths "			1.75
Shingles " sawed	2.10	@	2.40
" cedar	2.00	@	2.20
Pickets, pine	9.00	@	19.00
Posts, cedar	9.00	@	21.00
Pine, yellow southern	28.00	@	35.00
PINE, YELLOW GEORGIA,			
1st and 2nd clear, 4 inch flooring			35.00
" " " 6-inch "			35.00
Boards	33.00	@	35.00

HARDWOODS

Ash, 1st and 2nd, 1 inch	23.00	@	25.00
Maple, " " "	20.00	@	21.00
Walnut " " "	100.00	@	175.00
Oak White, 1st and 2nd, 1 inch	16.00	@	38.00
" Red " " "	22.00	@	24.00
Cherry " " "	65.00	@	85.00
Beech, Red " " "	25.00	@	30.00
Whitewood " " "	22.00	@	28.00
Birch, Red, 1st and 2nd, 1 inch	23.00	@	25.00
Butternut " " "	30.00	@	40.00
Sycamore " " "	22.00	@	25.00
Gum " " "	20.00	@	23.00
Basswood " " "			20.00
Hickory " " "	26.00	@	30.00
Elm " " "	14.00	@	16.00
Chestnut " " "	32.00	@	37.00
Rosewood, per lb	3c.	@	15c.
Mahogany, Mexican, per ft	.15c.	@	.20c.
" St. Domingo, per ft	.20c.	@	.25c.
" Cuba, per ft.	.12c.	@	.20c.
California Redwood Lumber	42.50	@	44.50
" Shingles	4.60	@	4.90
" Pine	65.00	@	75.00
Mexican Spanish Cedar	150.00	@	300.00
Georgia Cypress Lumber, 1st and 2nd clear	35.00	@	40.00
Georgia Cypress Shingles	3.75	@	4.25
CALIFORNIA OAK.			
Plank	23.00	@	25.00
Timber	24.00	@	30.00

PAINTS.

			Dry.		In Oil.
Lead, White (American) Dry			7		7½
Zinc " "			8, 10, 10	@	12
Red Venetian			2.6		12
Vermillion				2 @	75
India Red				15 @	20
Yellow Ochre				6 @	10
" Chrome	12	@ 20	12	@	20
Green "	12	@ 15	10	@	16
Black, Lamp	8	@ 25	10	@	15
Putty		Bulk	.2	Bladders	.3
Blue, Ultramarine			.16		.35
Whiting, dry			.1		
Litharge—American			.7		
Sienna, burnt			.9		.16
Umber, burnt			.7		.16
Oil, Linseed (raw) per gal			.44		
" (boiled) "			.47		
Turpentine "			.38		
Varnish, coach			1.35	@	2.00
" shellac			3.25	@	4.00

ASPHALT.

BARBER ASPHALT.			
Pavements Laid:			
Without foundation, per sq. y			2.00
With " " "			3.00
Asphalt Blocks:			
Macadam foundation, per sq. yd	2.81	@	2.97
Without macadam foundation, per sq. yd			2.75

Contractors Intelligence,

Reported by T. H. Boorman.

Engineering and Building Materials.

WHOLESALE PRICES.

New York, September 9, 1886.

IRON.

STRUCTURAL IRON.		
Angles	1.95c @	2.10c
" steel	2.35 @	2.45
Tees	2.35 @	2.45
Beams and channels, American	3.0 @	
Tank plates	2.10 @	2.20
Shell plates	2.4 @	2.5
Steel plates, Tank	2.70 @	2.75
WROUGHT-IRON PIPE. PITTSBURG.		
Butt welded, black ... Discount		45
" " galvanized "		35
Lap welded, black "		60
" galvanized "		42½
Boiler tubes "		52½
RAILS.		
Steel (large lots at mill)	$31.00 @	$34.50
Old rails	20.00 @	20.50
Old rails, steel	22.00 @	23.00
R R. spikes		2.40c
R R. splice-plates	1.80 @	2.00
R R. track bolts, square nuts	3.00	
Barb-wire fencing, galvanized	4.00 @	4.38
" painted		4.00
Corrugated iron		
Nails		
Iron, per keg	2.10	
Steel do.	2.20 @	2.25

METALS.

COPPER.		
Lake Superior	10.25 @	10.38
Other Brands	98-25 @	9.75
LEAD.		
Com. Domestic	4.75	
Lead Pipe	.06¼c.	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.07¼	
ZINC.		
Sheet	5.60 @	5.85

BRICK.

argoes (afloat)		
Choice Brands	7.25	
Haverstraw per M.	6.50 @	7.25
Fishkill	6.25 @	6.50
Up-River	5.50 @	6.25
Jerseys	5.75 @	6.25
Long Island		
Pale	4.50 @	4.75
FRONTS.		
Croton, red	11.00 @	15.00
" dark	11.00 @	15.00
" brown	10.00 @	14.00
Philadelphia pressed	27.00 @	28.00
Trenton "	25.00 @	26.00
Baltimore "	37.00 @	41.00
Buff "	33.00 @	35.00
Enameled English	85.00 @	130.00
" American	80.00 @	120.00
Fire brick	25.00 @	55.00
" American, No. 1	30.00 @	35.00
" " No. 2	25.00 @	30.00

ASPHALT.

ROCK.		
French, per ton	$20.00 @	25.00
German	15.00 @	20.00
According to quantity or brand, and whether taken from vessel or store.		
PAVEMENT.		
Barber's Asphalt	$2.50 @	$3.00

LIME.

Rocklock Cement Co.'s Ground	.80
Rockland, common per bbl	1.00
" finishing	1.20
State, common	.85
" finishing	1.05
Kingston, ground	.90
Add 25c. to above figures for yard rates.	

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.95 @	1.00
" " No. 2 "	0.75 @	0.85
" " light drab "	0.80 @	0.95
Berlin " in rough "	0.75 @	1.00
Berea " " "		
Brown stone, Portland, Ct. "	1.00 @	1.35
" Belleville, N. J. "	0.75 @	1.35
Granite, rough	0.45 @	1.25
Common building stone per load	2.00 @	3.00
se stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40 @	3.00
oncrete and macadam stone, Tomkins Cove, per cub. yd		$1.65

SLATE.

Purple roofing per square	6.00 @	7.00
Green "	6.00 @	7.00
Red "	15.00	
Black Penna. (at New York) "	4.50 @	5.00

LUMBER.

Prices for yard delivery in New York.

INE, Common box per M.	18.00 @	20.00
Choice "	65.00 @	70.00
Tally plank, 1¼ in. 10 in. dres'd. each.	.44 @	.50
Tally boards, dressed com. "	.28 @	.30
PRUCE, Boards dressed "	.35 @	.38
Plank, 1¼ in "	.28 @	.30
" 2 in. "	.38 @	.40
" 2 in. dressed "	.43 @	.45
Timber per M.	13.00 @	18.00
HEMLOCK, Boards each.	.18 @	.20
Joist, 2¼ × 4 to 4 × 6 in	.16 @	.44
OAK per M.	55.00 @	65.00
CYPRESS 1, 1¼, 2 and 2½ in "	35.00 @	40.00
YELLOW PINE, Girders "	25.00 @	30.00
Dressed flooring "	28.00 @	35.00
SHINGLES, Extra shaved pine, 16in. "		
" sawed 18 in. "	5.75 @	6.00
LATH, Cargo rate "	2.00 @	2.10

PAINT.

Lead, white, American dry per lb	.04¾ @	.06¼
" " " in oil pure	.07 @	.07½
" English, B. B. in oil	.08½ @	.08¾
" Red, American	.06½ @	.07
Litharge "	05½ @	.06
Venetian red, American "	.01 @	.01¼
Indian red "	.08 @	.10
Vermillion, American lead "	.10½ @	.11½
Paris green "	.15 @	.18
Umber, Amer. raw and powdered per lb.	.01¼ @	.01¾
Drop black, Amer.	.07 @	.18
" Eng.	.11 @	.13
Chrome green	.10 @	.25
Oxide zinc, American	.03¾ @	.03¾
" French	.05⅞ @	.07⅞

CEMENT.

The following price currents is made up entirely from quotations furnished us directly by the firms dealing in each brand; the prices are understood to be wholesale in New York, subject to such special rates as large quantities may warrant:

CALVIN TOMKINS:	
"Old Newark Co's." Cement	$1.10
BAETJER & MEYERSTEIN:	
Hanover Port and	$2.60 @ $2.65
BELLONI & Co.:	
Hemmoor "Crown" brand	2.50
JAMES BRAND:	
Burham	2.25 @ 2.50
Fewen	2.25 @ 2.50
BROOKS, SHOOBRIDGE & Co.	2.45 @ 2.60
HOWARD FLEMING:	
Gibbs' English Portland, 400 lbs	2.50 @ 2.75
K. B. & S. "	2.25 @ 2.50
Stettiner, German	2.65 @ 2.85
Lagerdorfer, "	2.45 @ 2.75
Fieve A 1, Belgian	2.35 @ 2.50
Roman	2.75 @ 3.00
Keene's Coarse	4.75 @ 5.50
" Fine	7.75 @ 8.50
" Superfine	8.50 @ 10.00
FISHER, ERSKINE W.:	
Stettin (German) Portland Cement	2.40 @ 2.75
GABRIEL & SCHALL:	
Vorwohler "Lion"	2.65 @ 3.10
HUDSON RIVER CEMENT Co. Rosendale	0
JOHNSON & WILSON:	
Saylor's American Portland	2.15 @ 2.45
LESLEY & TRINKLE, Philadelphia, Pa.:	
"Giant" Portland	2.20 @ 2.40
Improved "Union"	1.25 @ 1.50
Union	1.10 @ 1.20
MARCIAL & Co.:	
J. B. White & Bros. Coarse Keene's	4.25 @ 4.50
" Superfine	7.25 @ 7.50
" Portland	2.65 @ 3.00
NEW YORK CEMENT Co.:	
Rosendale	1.10
N. Y. & ROSENDALE CEMENT Co.:	
Rosendale, "Bridge" brand	1.10
SINCLAIR & BAUSON:	
Alsen's Portland Cement Works	2.35 @ 2.85
K. B. & S.	2.25 @ 2.50
STANDARD CEMENT Co	
E. THIELE:	
Dyckerhoff	2.90 @ 3.25
UNITED STATES CEMENT Co.:	
English Portland	2.25 @ 2.40
German "	2.00 @ 2.15
Standard	1.50 @ 1.65
Windsor and Improved Rosendale	1.00 @ 1.10
UNION AKRON CEMENT Co.:	
Akron "Star" brand	1.00 @ 1.10

MARKET SUMMARY.

The Brick Market continues firm, with heavy sales reported, Haverstraw and Jersey are a quarter higher, the former not being attainable for less than $6.50 per M, with choice lots in demand at $7.25. Jerseys are selling at $5.25 to $6.25 per M. Pressed Brick are in good demand. Croton meet with more inquiry, cheap lots are pretty well cleared out and first quality is fetching $15.00 per M for red and dark and $14.00 for brown. Lumber is in fair demand at last week's prices. Spruce Timber sells from $13.00 to $18.00, according to desirability of schedule. Yellow Pine random cargoes, $18.00 to $19; special cargoes, $19.50 to $21.00. Lath is precisely as last week, large cargoes selling at $2.00 per M, and lots of 300,000 and under at $2.10. Rosendale Cement meets with more inquiry, chiefly from out of town the prices are not yet stiffened up but no good quality can be bought at less than 95c. per barrel, and sales of favorite brands have been made at $1.10 per barrel. Portland Cement continues to be in request, the importations for this year up to September 1st are over 300,000 barrels, with heavy shipments made direct from Europe to Boston, Philadelphia, New Orleans and other ports on the sea board; the business being so large there is an active competition among the importers, and sales are made on very close margins and English Cement has been purchased as low as $2.10 ex-ship on large orders; first-class German has been sold at $2.20; small lots sell at $2.50 @ $2.75. Lime is reported unchanged in price, not much on the way and all now in port discharging or sold. Plaster remains the same and Hair shows no fluctuation in value. Paints have not attracted special attention; sales good at previous prices. Linseed Oil abont as last week, with sales of City at 43c. and Western at 42c. per gallon. Turpentine a little higher, 35½c. per gallon being now asked. Pig Tin is somewhat lower, London price having declined and sales for Straits have been made as low as 21 60c. has been accepted for Straits. Tin Plates are still in an uncertain condition, with little doing. Lead has been very dull, and sales of Domestic have been made at 4¾c., with Foreign offered at same figure. Zinc, 5½c. to 5⅝c. per pound. Half and half Solders, 14⅜c. to 15⅛c. per pound. Extra, 14c. @ 14½c. The Hardware Market continues inactive, with concessions frequently made from list prices. Nails move very slowly, and it is now conceded that car-load lots can be bought at $2.00 per keg, with $2.15, the highest price for Store lots.

BUILDING ITEMS.

Messrs. Rotch & Tilden, of Boston, are the architects for a five-story brick residenc, 25x68, to be erected for Mr. M. L. Schenk, at a cost of $30,000 at No. 6 West 56th street.

Messrs. Wm. Schickel & Co. have drawn plans for a three-story brick dwelling, 25x48, to be built for the Sisters of the order of St. Dominick at No, 137 Second street, at a cost of $10,000.

Messrs. Thom & Wilson have prepared plans for a five-story brick flat with store, 25x96.5, to be built by Michael Giblin, together with four four-story brown-stone houses adjoining, on the northwest corner of 59th street and Ninth avenue, at a cost of $100,000.

Mr. Richard Berger has designed six five-story brick flats, to be built on Seventh avenue from 123rd to 124th street, West Side, to be built for Lucas Sullivan, at a cost of $124,000.

Mr. Jos. M. Dunn has prepared plans for the interior alterations to be made to Nos. 34 and 36 Broad street for Mr. Francis P. Furnald, to cost $6,000.

Mr. J. Ireland, 67 West 23rd street is prepairing sketches for a four-story building, which the Brush Electric Light Co. propose to erect on Elizabeth street.

Mr. C H. P. Gilbert, 18 Broadway, has on hand plans for eight three-story and basement residences, which John Browne, the stone contractor of Hoboken, proposes to build on the east side of New avenue between 105th and 106th street, at a cost of $64 000.

Messrs. A. B. Ogden & Son are the architects for two five-story brick and brown-stone flats, to be built at a cost of $32 000 by Messrs. W. H. & R. E. Johnson, on the north side of 92nd street, 100 feet west of Third avenue.

Mr. Andrew Spence is preparing designs for additions to be made to the Hebrew Sheltering Guardian premises on the Grand Boulevard between 150th and 151st street, which will cost about $15,000

Mr. Wilbur S. Knowles, 189 Broadway, reports plans now on the boards for a $8,000 residence, to be built for Mr. W. F. Brown at Larchmont Manor, N. Y.

On the northwest corner of Eighth avenue and 136th street, four five-story flats are to be built, at a cost of $77,000 by Mr. W. Terriberry.

Mr. Samuel Stratton will build a three-story residence, to cost $15,000 on the west side of Webster avenue, near 179.

The contract for building the large model tenement for the Cutting estate at the corner of Avenue C and Fourteenth street has been awarded to Mr. Isaac A. Hopper.

Mr. James Stewart, of Yonkers, has been awarded the contract for building the Yonker's Surface Railroad.

Messrs. John Cox & Co. have been awarded the contract for repairing the Harlem Reception Hospital at a cost of $9,525.75 and for erecting a new drug house for Bellevue Hospital, at a cost of $11,425.

The Police Commissioners will have built on the north side of 67th street, between Lexington and Third avenues, a station-house, lodging-house and prison. Estimates for erection of the building will be recived up to the 21st, September.

Mr. W. Burnet Tuthill reports plans on the boards for ten three-story brick, stone and terra-cotta residences which are to be built for Mr. George S. Ferris on Manhattan avenue and 115th and 116th street: seven will be 20x40 and three 16.8.50 in size; cost not yet estimated.

Mr. Harris C. Blanchand reports plans on hand for alterations to be made to the residence of Mr. J. H. Goodrich, Oxford street, Brooklyn.

Messrs. Post & McCord have been awarded the contract for the iron-work of the Presbyterian Hospital, 71st street and Madison avenue.

The contract for the construction of the Newburg street railway has been awarded to Mr. John Graham, of New York.

TRADE NOTES.

SPECIFICATIONS FOR BUILDINGS.—Messrs. Palliser, Palliser & Co., 5, 7, 9 and 11 Vanderbilt avenue, New York City, have forwarded to us a copy of their new, revised and improved form of specifications for frame or brick buildings, costing from $1,500 to $10,000. These forms seem excellently adapted to their purpose, as furnishing data for the mason, carpenter, painter, etc., in the 22 folio pages of text given. Blanks are left so that the forms can be used direct, or they can be made to serve as gentle reminders of items and detail in prepairing specifications. The price is thirty-five cents each, or $3.00 per dozen.

IRON AND STEEL PRODUCTION IN THE U. S.—According to the 8th edition of the Directory of the American Iron and Steel Association, just published, there are now 578 blast furnaces in active operation, credited with a total annual capacity of 9,960,700 net tons, or 17,233 tons each, supposing them to be in full blast the whole year. The annual capacity of the rolling mills in finished iron and steel is 7,613,000 tons; about the same as in 1884. There are now twenty-seven standard Bessemer steel works with fifty-eight converters, and seven new plants in course of erection; two years ago there were but twenty works, with forty-five converters. The annual ingot capacity has increased from 2,490,000 net tons in 1884 to 4,102,000 tons in 1886. The Directory shows important progress in the erection of Clapp—Griffiths plant, and in open-hearth steel works, while crucible cast-steel is hardly holding its own. Pittsburg and Chicago are the great iron and steel producing cities of the country.

Residences.—W. H. Stoelker is about to commence the erection of a block of two three-story residences, 26x57 feet, at 427 and 429 La Salle avenue, Chicago, to cost abont $12,000. Fronts of pressed brick, stone, terra cotta, furnace heat, mantels, ornamental glass, and laundry fixtures.